Living in the digital ecosystem: technologies, organizations and human agency

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Preface

ItAIS (www.itais.org) was established in 2003 as the Italian Chapter of the Association for Information Systems (AIS - www.aisnet.org) and has since then been promoting the exchange of ideas, experience, and knowledge among both academics and professionals committed to the development, management, organization and use of information systems.

The ItAIS conference is the major annual event of the Italian Information System community and it is thought as a forum to promote discussions and experiences exchanges among researchers in the field, both from the academy and the industry. Being the current the fifteenth edition, in 2018 ItAIS was held in Pavia. The previous editions took place in Milan on 2017, Verona on 2016, Rome on 2015, Genova on 2014, Milan on 2013, Rome on 2012 and 2011, Naples on 2010, Costa Smeralda on 2009, Paris on 2008, Venice on 2007, Milan on 2006, Verona on 2005, and again Naples on 2004.

ItAIS 2018 aims to bring together researchers, scientists, engineers, and doctoral students to exchange and share their experiences, ideas, challenges, solutions, and research results about all aspects related to the impact of Information Technology and Innovation Trends in Organizations. The conference includes 9 tracks: (1) Organizational change and enabling technologies (2) Accounting Information Systems in the digital ecosystem (3) Digitalization trends in Human Resources Management (4) Socio-Technical perspectives on technology and human agency (5) e-Services, Social Networks, and Smartcities (6) Acting digitally in a digital society: the force and the dark side of online communities (7) User-driven innovation in the public and private sector: participation, engagement and coproduction (8) The challenges of digitalization in healthcare and in the public sector, between technologically dense environments and governance (9) Digital technology for learning: a transformational process

The participation success that has been registered in the previous editions is confirmed this year. The conference attracted more than 80 submissions from Italian and foreigner researchers. Among them, about 60 contributions have been accepted for presentation at the conference following a double-blind review process. Among them, 11 are published in this book, the other will appear in a volume of the Springer Series *Lecture Notes in Information Systems and Organisation* (http://www.springer.com/series/11237).

The ITAIS conference took place at the University of Pavia, on October 12th – 13th, 2018 and is organized in 4 parallel sessions.

We would like to thank all the authors who submitted papers and all conference participants. We are also grateful to the chairs of the nine tracks and the external referees, for their thorough work in reviewing submissions with expertise and patience, and to the President and members of the ItAIS steering committee for their strong support and encouragement in the organization of ItAIS 2018. A special thanks to all members of the Organizing Committee for their precious support to the organization and management of the event and in the publication of the enclosed proceedings.

October 13, 2018

The Book Proceedings editors
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Building Bridges Between the Curricula of Italian Universities in Logistics & SCM and the Needs of 4.0 "Customer-Centric" Enterprise Professionals*

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Abstract. This research focuses on the key and central role of logistics and supply chain management (SCM) today [17, 28] and the importance of having professionals with specific professional/technical skills together with an adequate educational background. In light of an analysis previously carried out concerning the mapping of roles and skills required to effectively operate in logistics and SCM [2], this study queries whether Italian universities (along with other training institutions) are ready to fulfill these needs. Inspired by Niine and Koppel [26, 27], who argue that "logistics is an extensive interdisciplinary field across industries and jobs, merging the viewpoints of engineering, manufacturing, operations and business administration", the study proposes a census of the courses (Bachelor and Master's Degree equivalent) offered by the Faculty of Economics and Engineering in the 2017–2018 academic year and the list of the main jobs in the logistics and SCM area with the main technical competences. Aim of the research is to understand if Italian Universities are able to offer the "logistics culture" consistent with the evolving markets' needs.

Keywords: logistics, supply chain management, company-centricity, industry 4.0, innovation 4.0, technology, competences First Section

* A preliminary version of the paper was presented at PROLOG Project Logistics, Logistics Institute, University of Hull, Kingston upon Hull, East Riding of Yorkshire (UK), June 28-29th 2018.

1 Introduction

In the past, companies were defined as "company-centric": as noted by Shah, Rust, Parasuraman, Staelin, and Day [6] "economies of scale and scope were central, because profits were primarily a reflection of market share". "As a result, firms were more internally oriented, with their attention focused on manufacturing superior products rather than on being oriented toward the purchasers and users of those products" [18]. In this perspective, logistics was often considered a function with low added value, its management being subject to medium/long-term outsourcing contracts [36].

Recent and authoritative analysis of trends, strategies and challenges [12, 23] show that the scenario is profoundly changed because of external (exogenous) and internal (endogenous) forces. Cost pressure, individualization of products/services and complexity remain top exogenous trends, while digitalization of business processes and transparency in the supply chain are the most important company-driven trends. The Authors of the study underline that priorities for SC professionals are concentrated on two unavoidable goals: accomplishment of customer requirements (often identified with reliable/on-schedule delivery) and logistics costs reduction. Again it is possible to recognize an external focus (customers) and an internal focus, the efficiency of business processes, a mainstay of logistics management.

The digital transformation - currently underway - pushes towards the identification of a new balance between the internal and external needs [24]. Hence the need to find a sustainable trade-off between the two perspectives (*company-centric* and *customer-centric*) that emerge as conflicting but need to be managed as not opposing. This results by offering the customer a positive and ever more personalized purchasing experience and leveraging at the same time on typical logistics parameters, like product availability and short delivery time [10]. This strategy implemented on a global scale by the e-commerce major players has led to the current situation in which consumers are highly-informed and expect - even by minor players of the market - very high logistics service levels in terms of both product availability and short delivery times. In other words, standards imposed by the majors need to be guaranteed also by the minors if they want to survive on a very competitive arena.

The impact of this scenario in terms of skills and competences required to manage logistic flows is evident: a broader and more sophisticated skillset is needed in order to meet the consumer's expectations and at the same time ensure efficiency to the system.

The paper is structured in 5 sections. Section 1 presents the scenario in logistics and SCM, followed by the delineation of the conceptual framework and research questions in Section 2. The subsequent Section 3 is entirely devoted to the explanation of the methodology adopted, articulated in different and sequential steps. The results are then presented in Section 4 and the paper concludes with Section 5 dedicated to the discussion of the findings.

2 Conceptual Framework and Research Questions

Compared to the traditional notion of logistics - as pertaining to auxiliary functions within the enterprise - a much more open and complex concept is rising in theory and practice [1, 3, 5, 15, 31]. Indeed, modern logistics is understood both:

- as a system/network that manages physical, informational and financial flows linking a plurality of enterprises participating in a single supply chain [29];
- as a "*process of strategically managing the procurement, movement and storage of materials, parts and finished inventory (and the related information flows) through the organization and its marketing channels in such a way that current and future profitability are maximized through the cost effective fulfillment of orders*" [8, pag. 4].

So conceived, it plays a significant role in coordination between different nodes and functions: in this respect, the ability to integrate logistics with other business functions [30, 37, 39] is one of the qualities that a good logistics manager must possess [16], in addition to knowing how to interact with different companies operating in the same supply chain (suppliers, customers, logistics operators, etc.).

In brief, the changing role and structure of logistics, the growing awareness of the customer, and the digitalization in progress [5] necessarily imply changes in demands in terms of professionalism.

Inevitably, the need for qualified resources poses the problem of adequate training [25, 33]. This research aims to understand:

which professional jobs/figures operate in logistics and SCM and which professional/technical competences they must possess

if Universities are delivering curricula consistent with these professional needs.

Research questions (RQ) can be summarized as follows:

RQ(1): Which professional figures/job operate in logistics and SCM?
RQ(2): Which professional/technical competences must they possess?
RQ(3): Which courses in logistics and SCM are delivered by Italian Universities?

To summarize, as competitive advantage is unquestionably connected to the skills, knowledge and abilities of the professionals operating within the company (in all functions, but in this case essentially in logistics and SCM), this research aims to:

- map the professional figures/job operating in logistics and SCM
- map the professional/technical skills/competences they must possess
- map the courses in logistics and SCM delivered by Italian Universities

with the final goal to understand if there is a match or mismatch between Italian Universities' curricula in Logistics and SCM and the markets'needs.

3 Methodology

The research is simultaneously carried out on two fronts: the companies - that require highly skilled professionals able to efficiently interact with the above described scenario - and the universities - in charge of the training of these professionals.

This is the reason why the Authors of the current research proceeded with a dual methodology.

From the companies' side, the study verified the presence of standards of competence recognized by logistics professionals in the market. This reconnaissance highlighted the presence of the following competence models for logistics and SCM professionals:

- The European Logistics Association (ELA). The ELA Qualification Framework (ELAQF) is structured in three levels, limiting its scope to levels 4, 6 and 7 of the more general European Qualifications Framework (EQF) developed by the European Commission [9]. The ELA identifies the Operational/Supervisory Management level (EQF level 4), the Senior Management level (EQF level 6) and the Strategic Management or Master's level (EQF level 7). Both levels 4 and 6 are structured into three competence areas: Supply Chain Design, Supply Chain Planning and Supply Chain Execution, the latter of which is further divided into Transport Management, Warehousing, Sourcing and Customer Service. An important trait of the ELAQF is that the standards are regularly updated by a panel of logistics and SCM managers and experts.
- The American Production and Inventory Control Society (APICS). This identifies two classes of competence: basic and professional. Professional competences are divided into three knowledge areas (operations management, distribution and logistics) and basic skills are structured around personal traits and attitudes. While competences such as problem solving, continuous learning and integrity are clearly relevant and it is important that managers develop them, they are not directly recognizable in university undergraduate curricula. Because of this, only the professional competences of the APICS model can be considered.
- The International Society of Logistics (SOLE). This organization approaches professional qualifications by placing considerable emphasis on technologies and promoting the merging of managerial and engineering approaches to logistics. The SOLE professional qualification system is articulated in five levels: Demonstrated Logistician (DL), Demonstrated Senior Logistician (DSL), Demonstrated Master Logistician (DML), Certified Master Logistician (CML) and Certified Professional Logistician (CPL). Step-by-step career progression implies performance evaluation, compliance with well-defined educational requirements, as well as mastering an additional set of functional and enabling skills. Professional experience, diplomas and educational prerequisites to access qualification levels are flexible and interrelated. According to the SOLE qualification scheme, those who hold a Master's degree can directly access the CML level. It is interesting to note that SOLE advises a model of typical university courses considered appropriate for the education of logistics professionals. This model is built on four pillars: systems management; system design; purchasing and maintenance; distribution and customer service.

- The Chartered Institute of Logistics and Transport (CILT). CILT offers three levels of qualification [7]: International Certificate in Logistics and Transport (level 3 in the EQF), International Diploma in Logistics and Transport (level 5 in the EQF) and International Advanced Diploma in Logistics and Transport (level 6 in the EQF, a level usually requiring a university degree). These three qualifications are issued following the attendance of a training programme delivered by CILT and consisting of different modules (12–20, according to the level), accounting for a substantial course workload of 240–360 hours spread over a period of 12–18 months. According to CILT, "the Certificate operates at Level 3 (A level/post-18 school/college leaver standard), while the Diploma is aimed at those already working in the industry/sector at a middle management level and who wish to develop a strategic view of logistics and transport operations. The Advanced Diploma operates at level 6 of the EQF and its focus is on strategic logistics and transportation management".

Once mapped the standards of competence, it has been necessary to define which one to adopt. The standards had to be:

- internationally acknowledged and
- clearly structured in knowledge and competence areas
- to be suitable for comparison with "target competences" provided by university curricula.

As the scope of our research spans Italian universities, it has been considered as to be more appropriate to focus the research on the two models frequently chosen by Italian logisticians: APICS and ELAQF. Of these, only ELA has mapped its competence levels according to the EQF. Because of this feature, in Italy the ELAQF has a decided advantage when considering national and regional qualification frameworks as possible elements for comparison with university curricula (or even inputs, as teaching programmes of Higher Technical Education Schools [ITS]).

Because of this, it was decided to adopt the ELAQF as a reference standard in our research. We excluded CILT diplomas and the SOLE system as they are virtually non-existent in the Italian business practice.

After establishing which standards to include and having justified the selection criteria, a matrix containing the main jobs in the logistics and SCM area and the main technical competences associated with these job descriptions has been prepared. These competences were then aggregated following the ELA standard scheme as a guideline. Considering that top management positions are accessed exclusively through a professional career pathway (linear, spiral, transitory) and that the "core business" of universities consists of preparing young students starting their career pathway (and noting that while MBA programmes contribute to developing top management competences and skills, but are not the core business of most universities), the research is naturally framed in terms of the skills and competences of white collar workers and managers.

In light of the aggregation thus made, a matrix was used to match the technical professional macro competences necessary to work effectively in logistics and SCM with the target competences that can be developed by the programmes of Italian universities.

On the **universities'side**, the research mapped the curricula of Bachelor's and Master's degree courses provided by the Faculties of Engineering and Economics as these degrees are the ones that provide entry level roles (the decision taken not to apply a similar aggregation to the skills

and competences of top management profiles is justified by the fact that our research does not cover executive or MBA programmes).

The boundary of the research was drawn around the graduate and undergraduate courses offered by the Faculties of Economics and Engineering in the Italian territory, excluding executive programmes, Istituti Tecnici Superiori (ITS), master's courses and those delivered by private providers as "distant" in terms of aims, organization and resources and lacking a rigorous, integrated and modular model.

4 Results

By applying the methodology depicted above, the following results have been achieved. From the companies' perspective, jobs have been clustered into three groups, namely: white collar or operational workers (Tab. 1), managers (Tab. 2) and top management (Tab. 3). Column 1 identifies the (short) job tile, while column 2 describes a basket of essential competences assigned to each job.

Within the first group (Tab. 1) we essentially found figures with operational responsibility for managing the execution of activities in SCM processes.

Tab. 1. Operational/white collar jobs and related competences

Job/Figure	**Competences**
Inventory Control Administrator	Administer inventory, supply and capacity data
Warehouse Administrator	Ensure correct follow up of warehouse/logistics administrative matters
Traffic Administrator	Administer the shipping of goods within defined guidelines
Buyer/Purchaser	Timely placement of purchase orders and delivery of materials to meet customer order requirements and maintain stock inventory levels within approved guidelines
Customer Service Representative	Provide customer service support by obtaining and executing the order information in a timely manner
Supply Chain Analyst	Analyse product delivery, logistics or supply chain processes to identify and recommend improvement actions
Supply Chain Systems Analyst	Support the systems that form the foundation for the execution of the supply chain business process
Planner (alternative role: Inventory Controller)	Evaluate current inventory and ensure appropriate allocation of free and obsolete inventory
Warehouse Supervisor	Oversee warehousing operations
Transport Specialist/Transport Supervisor	Ensure the shipping of goods, respecting quality, legal and cost parameters

Senior Buyer	Develop, negotiate and administer contracts and agreements. Negotiate specifications and statement of works
Customer Service Supervisor	Provide effective management and leadership of a team of customer service representatives, ensuring service and efficiency targets are achieved and maintained
Supply Chain Re-Engineering Manager (alternative roles: Supply Chain Project Manager, Continuous Improvement Manager)	Design logistics processes, technology and/or infrastructure to support the efficient and cost-effective management of the supply chain

Managers play a leading and controlling role within a well-defined functional area of the company's supply chain. Also for this second group it has been identified a basket of necessary skills, as shown in Tab. 2.

Tab. 2. Managerial jobs and related competences

Job/Figure	**Competences**
Supply Chain Project Manager	Develop and deliver projects to provide business benefits: sales growth, margin improvement, supply cost reduction and inventory optimization
Planning Manager (alternative roles: S&OP Manager, Demand Planning Manager, Inventory Manager)	Ensure the development of the master material plan and the production plan to meet the agreed delivery requirements, optimizing asset utilization
Warehouse Manager	Develop and manage warehouse operations in order to control and ensure the effective and efficient receipt, storage, picking and dispatch of products, systems and services to customers
Transportation Manager	Develop and manage transport operations to control effectively inbound and outbound shipping of products, systems and services to customers
Sourcing Manager (alternative roles: Purchasing Manager, Procurement Manager, Sourcing Manager)	Develop, negotiate and administer contracts and agreements to meet agreed improvements in cost and quality
Customer Service Manager	Develop and implement order management activities to control effectively order taking, order allocation and invoicing of products, systems and services to customers
Supply Chain Re-Engineering Lead/Supply Chain Project Director	Design logistics processes, technology and/or infrastructure to support the efficient and cost-effective management of the supply chain
Supply Chain Change Management Lead	Initiate and manage the supply chain transformation programme
Planning Director (alternative roles: Director of Supply Chain Planning, Head of Logistics, Head of Supply Chain)	Develop strategic and operating plans to ensure that the company has the appropriate resources to support current forecasted and projected growth

Head of Logistics	Plan and ensure the correct management of logistics processes and related flow of information and products in order to achieve defined targets for the customer service level, operational costs and inventory levels
Director of Sourcing (alternative roles: Head of Procurement, Procurement Director)	Provide a complete procurement function for all the company expenditures, with external suppliers at the forefront regarding implementation and the development of procurement strategies

Top management carries the utmost responsibility for all strategic choices related to the corporate supply chain. Tab. 3 summarized the top management roles and related competences.

Tab. 3. Top management roles and related competences

Job/Figure	**Competences**
Vice President of the Supply Chain (alternative role: Vice President of Operations	Collaborate with suppliers, customers and regulators to implement innovative strategies to deliver the sustainable supply chain service and cost improvements
Vice President of Transportation	Collaborate with suppliers, customers and regulators to implement innovative strategies delivering a sustainable transportation service and cost improvements
Director of Strategic Sourcing	Develop and implement sourcing strategies and systems to deliver breakthrough performance improvements

The proposed tables highlight roles and related technical skills for the three levels of the ELA standards. Such a picture, although extremely useful when viewed as an organizational design tool, is not entirely suitable for comparing university target skills with those needed by the market. Because of this, it has been considered appropriate to develop and further aggregate the analytical skills identified into a matrix of skills for line managers (EQF level 4, Tab. 4) and senior managers (EQF level 6, Tab.5). Top management roles have not been included as attending a university programme is not sufficient to access such roles and a substantial period of work experience is necessary.

Tab. 4. Synthesis of operational competences/line management (EQF level 4)

Competence area	**Competences**
Demand, Production & Distribution Planning	Plan and manage inventory, supplies and capacity. (Plan current and future inventory in order to ensure a proper level of service to internal and external customers, respecting all economic and financial constraints)
Warehousing	Coordinate planning and execution of warehousing operations to ensure the timely and accurate fulfilment of production or sales orders using available resources efficiently and effectively
Transport	Ensure shipment of goods respecting the agreed service and quality parameters as well as economic and legal constraints

Supply Chain Design	Analyse, design and improve the processes, technologies and plant infrastructure that support efficient and effective supply chain operations
Sourcing	Develop, negotiate and manage supply contracts to satisfy the planned production requirements of internal and external customers, respecting the agreed time and economic parameters
Customer Service	Support customers by monitoring the correct development of the order fulfilment process

Tab. 5. Synthesis of directional skills (EQF level 6)

Competence Area	**Competences**
Demand, Production & Distribution Planning	Develop strategic and operational planning to ensure the organization has adequate resources to support its planned and current development
Warehousing	Develop, manage and improve warehousing operations by coordinating inputs from all of the assigned resources
Transportation	Develop, manage and improve transport operations to ensure product shipment to external or internal customers
Sourcing Manager (alternative roles: Purchasing Manager, Procurement Manager, Sourcing Manager)	Select best suppliers; develop, negotiate and ensure the regular development of supply contracts fulfilling all the agreed cost, quality and service parameters
Customer Service	Contribute to developing customer service strategies by managing order fulfilment and after-sales operations
Supply Chain Design	Managing supply chain transformation programmes by changing processes, technologies and supply chain infrastructure and ensuring the achievement of given improvement objectives

It is important to highlight that while the jobs shown in Tab. 1 (operational), Tab. 2 (middle management) and Tab.3 (top management) should be considered "company specific", or uniquely specified by each organization, competence areas shown at the operational (EQF level 4) and senior management level (EQF level 6) are essential building blocks of logistics as a management discipline.

From the Universities' perspective, in Tab. 6 a summary of the courses identified in the Italian faculties of Economics and Engineering (both undergraduate and graduate level) has been listed.

Tab. 6. Synthesis of courses identified in the Faculties of Economics and Engineering

	Economics (Bachelor's Degree)	Economics (Master's Degree)	Engineering (Bachelor's Degree)	Engineering (Master's Degree)	Others
Supply Chain Design	8	18	12	25	2
Inventory Control	3	15	21	22	1
Transport	7	10	19	22	1
Warehousing	3	8	15	21	
Demand & Strat. Planning	3	10	14	11	
Supply Management	2	6	7	13	
Providers management	1	6	4	8	
Logistics Performance Measurement	3	4	5	5	
Logistics Cost	2	3	2	9	
Reverse Logistics	1	1	5	8	
Customer Service	2	1	4	7	
Logistics Outsourcing	3	5	3	3	
Supply Chain Risk Management	0	4	2	3	

In Fig. 1 the total number of courses identified in the schools of Economics and Engineering of Italian universities (Bachelor's and Master's degrees) has been sketch while in Fig. 2 and Fig. 3 they have been splitted in bachelor's degree and master's degree course.

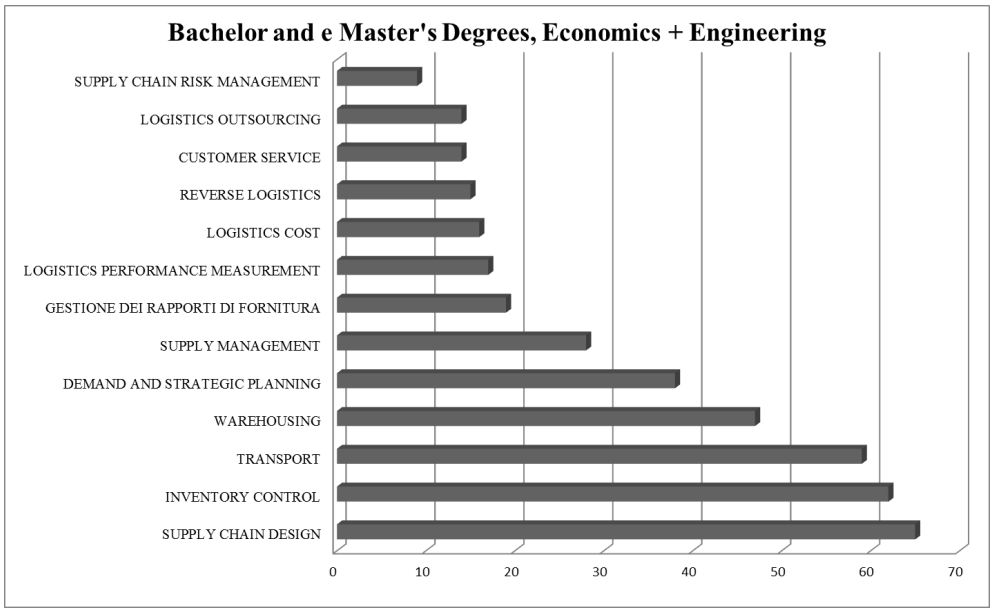

Fig. 1. Courses in the schools of Economics and Engineering of Italian Universities (Bachelor's and Master's degrees)

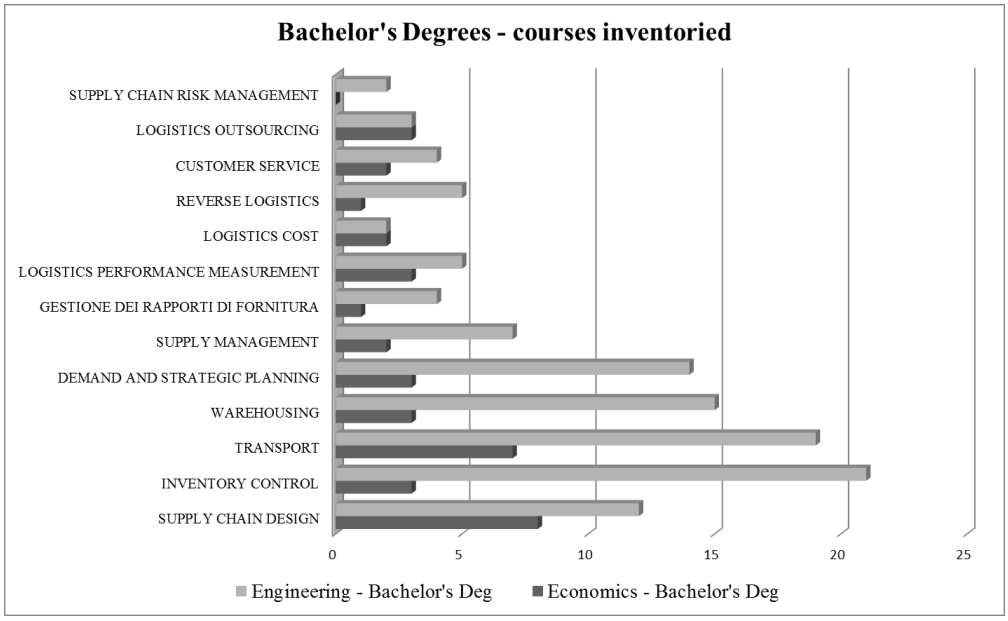

Fig. 2. Courses in the schools of Economics and of Engineering of Italian universities (Bachelor's degrees

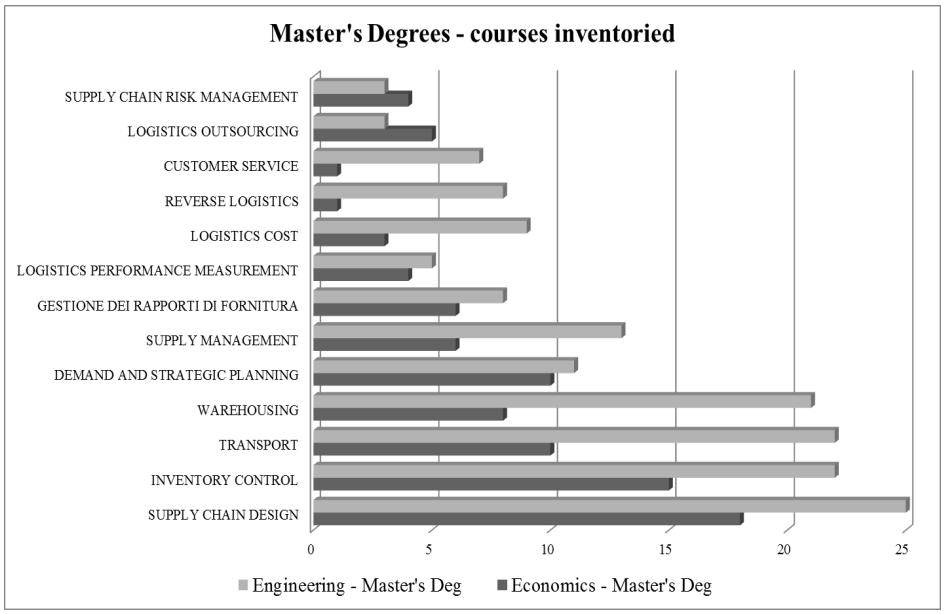

Fig. 3. Courses in the schools of Economics and of Engineering of Italian universities (Master's degrees)

Assessing the total number of courses, it is possible to note that logistics and SCM are still "game fields" dominated by schools of Engineering. The differences between Economics and Engineering become less conspicuous when limiting the analysis to Bachelor's degree courses, in which case the offers from Schools of Economics and Management are quantitatively very similar. In terms of subjects, competences covered to a much greater extent are those related to the areas of transport, inventory, planning and supply chain network design. In contrast – and this is the most serious gap identified – competences less taught are those related to management control systems applied in SCM, together with reverse logistics, risk assessment and outsourcing strategies [35].

5 Discussion

This study was considered necessary to reflect on the courses offered by Italian universities to provide graduates with the technical and management tools required to operate effectively in logistics and SCM [4,11, 34, 38] The research, after having identified which professional figures/job operate in logistics and SCM (in response to RQ1) and mapped the necessary technical competences (RQ2), verified which courses in logistics and SCM are offered by Italian Universities (RQ3).

Bearing in mind the results of the analysis of business requirements in terms of jobs and competence areas (RQ1 and RQ2) and the training offers provided by Italian universities (RQ3), it becomes clear that there is a major gap between the competences required and topics being taught.

Assuming that one of the causes underlying this gap is the limited exchange of information between academia and business, these results advocate a systematic re-engineering of the contents of university curricula, not limited to minor or restyling updates. Moreover a robust involvement of the supply chain management associations in the redesign effort is necessary as they possess a clear and updated overview of the market situation.

Furthermore, re-balancing topics, competence areas and courses as follows should be fundamental:

There is overall little focus on critical business areas, such as the outsourcing of logistics, risk management, customer service, performance management and reverse logistics.

Bachelor's and Master's courses show a similar distribution of strategic (risk management, outsourcing, management control systems) and operational (transport management, production and inventory planning, warehousing) topics.

Courses delivered by schools of Economics and Management present a low focus on management topics (cost and performance analysis, reverse logistics, customer service, outsourcing).

In addition, to make the situation even more complex, it is necessary to take into account the increasing diffusion of Industry 4.0: thus, the need to evaluate the demand for professional skills related to 4.0 logistics and develop appropriate tools, such as the Professional Development Stairway for Logistics developed by Skills for Logistics aiming to adapt training programmes considering both employees already working in the company and students approaching the field with suitable tools and appropriate technical and professional skills [13, 21, 22, 32].

Finally, to build a bridge between companies and universities it should be strategic for both to have the competences acquired by students attending SCM university programmes certified by a recognized association [19, 20].

Articles by Niine and Koppel [26, 27] show a systematic approach to mapping curricula against competence models for logistics professionals; among the few systems available in Europe, the ELAQF stands out as the ELA has initiated an accreditation programme in which the contents of university curricula are mapped against ELAQF standards. The practical availability of such an accreditation system enables us to propose it as a feasible solution to heal the gap.

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How Do Online Fashion Retailers in Asia Use Facebook Marketing Strategies? A Case Study of FashionValet

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Abstract. In recent years, a number of businesses have taken to social media as a means of communicating and interacting with their customers. This situation reflects the evolving world of social media, which now exerts considerable influence with respect to customer engagement, branding, sales and even survival in a competitive business environment. The purpose of this paper is to explore the use of Facebook marketing strategies by a successful Malaysian online fashion retailer: FashionValet. Nvivo Pro 11 was used to capture and analyse the content of Facebook posts. This analysis of Facebook posts reveals the use of various marketing strategy aimed at promoting product awareness, including seasonal and promotional sales, contests and staff recruitment. This analysis also reveals the extent to which online fashion retailers in Asia consider customer engagement through Facebook to be absolutely critical. The findings of this study elucidate a number of creative approaches for exploiting Facebook posts more effectively and for turning them into valuable marketing strategies.

Keywords: Facebook, social media, marketing strategy, FashionValet

1 Introduction

With the advent of the information technology age, businesses have begun to look for novel approaches to turn information technology into sustainable competitive advantage. In recent years, social media has attracted considerable attention from businesses in various industries as a new means of communication [1]. Social media has relevance not only for regular Internet users but also for businesses. In particular, business should be aware that while they themselves might not be exploiting social media strategies, their competitors may have already embraced innovation and be using these strategies. Businesses use social media to market products, promote brands, innovate in products/services, connect with current customers, collaborate with business partners and to foster new business opportunities [2]. However, social media can be used for more than just enhancing collaboration and communication, it can also be a powerful strategic decision-making tool. Data mined from social media can provide a wealth of knowledge for the decision maker in support of a product or service innovation strategy. The advantage of social media is that it supports mutual interactions between customers and companies who wish to share their knowledge and to learn from one another, make improvements and to capitalise upon exchange-

process benefits. This situation is indicative of the social media phenomena, which has now evolved to exert a significant impact over business customer engagement, reputation, sales and even survival. However, many businesses ignore this form of media because they do not understand what it is, the various forms it can take, how to engage with it or how to utilise social media information [1,4].

2 Facebook Marketing Strategy

A Facebook marketing strategy might involve at least of the seven messaging typologies thought to affect the consumer decision-making process [5]. Coursaris et al. [5] identify seven categories of messaging: brand awareness, corporate social responsibility, customer service, engagement, product awareness, promotional and seasonal. This typology was developed based on a grounded analysis of various industries, including airlines, fast-food and grocery. Different industries require different kinds of marketing approaches for their specific products or services to attract and engage with their customers. This study extends the application of this industry-based marketing strategy to the context of online retailing in the fashion industry.

Online retailing, otherwise known as electronic retailing or e-retailing, is a critical component of e-commerce. E-retailing is considered a key player in the business-to-consumer space aimed at boosting the adoption of e-commerce in Malaysia [6]. The advantage of the e-retailing business model is that it provides ready opportunities for small and medium enterprises (SMEs) expand into e-commerce [7,8]. Most SMEs engage in the brick-and-mortar business activities, using traditional marketing networks and channels. The low participation of SMEs in e-commerce activities can also be attributed to the lack of confidence in digital platforms and the high cost of broadband access [9]. However, as online shopping channels mature and expand, competition among online retailers will inevitably grow more intense in both local and international markets. This increasingly competitive environment, coupled with the increase in the number and diversity of electronic consumers, highlights the importance of understanding exactly what constitutes an effective marketing strategy in relation to social media platforms [10].

This study seeks to explore the Facebook marketing strategy of a successful online retailer in the Asian fashion industry. FashionValet sells a wide range of exclusive collections from local and regional designers from across Southeast Asia. Fashion-related products to can be sorted according to various categorise, including clothing, accessories, beauty and jewellery. In Malaysia, fashion items are among the most frequently purchased items online [9]. FashionValet aims to facilitate the adoption of e-commerce platforms by local fashion SMEs with a view toward expanding their businesses. Local fashion SMEs benefit through their participation on the e-retailing fashion portal by intensify their customer relationship, systematising inventory management, order fulfilment and the delivery process, as well as by expanding their brand exposure through an effective marketing strategy. As a leading online retailer, FashionValet has been heavily focused on building its social media strategy and attracting a large following on Facebook by increasing its brand visibility in an online environment.

FashionValet was co-founded in 2010 by husband-and-wife team Fadzarudin Anuar and Vivy Yusof [11]. Despite starting with only three people and 10 brands, as of 2017 the company had grown to include approximately 150 employees and carries over 500 brands [12]. Moreover, FashionValet how has offices and warehouses in Malaysia, Indonesia and Singapore. *The Edge Malaysia*, the country's leading business and investment weekly magazine, while not revealing actual revenue figures, reported that FashionValet has seen a dramatic growth in revenue from approximately RM46K in 2010 to RM7.9 million in 2014. The report also estimated FashionValet's overall revenue for 2015 as RM13.1 million and RM39.5 million in 2016. FashionValet opened its Facebook account in 2010, and as of September 7, 2017, had 248K followers. Similarly, FashionValet's Instagram account was started in 2012 and currently has 521K followers.

As a social networking platform, Facebook allows users to share posts with the public, only with their friends, with a particular user or a select group of users. Facebook posts can contain a combination of text, photos, videos or website links. For the purpose of engagement, the *Like* button is the easiest way to express user interest and satisfaction in Facebook content. The *Share* action enables the user to choose what content they want to circulate within their social community. Alternatively, *Comment* enables users to express their ideas, voice complaints, comment or add information, either positively or negatively. By analysing what users *Like*, *Share* or *Comment* on, much can be learned about users' reactions to particular content. Moreover, on Facebook, users can preface words, acronyms or phrases with the hashtag symbol: #. The hashtag symbol is widely used across various social media platforms to form keywords that can be associated with particular context, topics, issues or events. Consequently, the use of the hashtag enables Facebook users to search for information and to follow or contribute to discussions around a particular topic. As such, the use of the hashtag is essential for organising information around specific topics being shared among groups of Facebook users. On the basis of this background, this study answers the 2 research questions, First, what do FashionValet posts on its Facebook page tell us about its marketing strategy? Second, how does FashionValet's Facebook marketing strategy influence consumer behaviour engagement?

3 Methodology

The population of this study is based on 237 posts to FashionValet's official Facebook page at https://www.facebook.com/FashionValet/. Data was collected over a 6-month period from 1 March to 31 August 2017. This timeframe is inclusive of the *Eid Al-Fitr* festive season, known locally as *Hari Raya Aidilfitri*. Like Christmas, Hari Raya Aidilfitri is a religious observance, celebrated by Muslims. Traditionally in Malaysia, it is consider auspicious ahead of Hari Raya Aidilfitri to procure new clothes to wear when visiting relatives and friends. As one of the main festive seasons in Malaysia, Hari Raya Aidilfitri is primarily celebrated by Muslims, who comprise about 70% of Malaysia's population of 32 million people. During the data collection period, Hari Raya Aidilfitri was held on 25 June 2017. Therefore, data collection occurred over the seasonal period.

Numerous studies by leading e-retailers in Malaysia have shown that e-businesses often create more online campaigns during festive seasons, like Hari Raya Aidilfitri, and see a significant increase in sales as a result. Most e-retailing businesses try to attract consumers with various marketing strategies to maximise their sales during festive seasons. What is interesting to note here is dramatic change in the behaviour of online shoppers during festive seasons. Similarly, 11street, a popular online marketplace, reported a 50% increase in sales during its 2018 festive season sales as compared to similar online seasonal sales in 2016 [11]. Lazada, another major player in the Southeast Asian online market, revealed about 70% Malaysian will be purchasing more online for Hari Raya Aidilfitri; moreover, apparel is one of the top 3 categories purchased for Hari Raya Aidilfitri [12].

This study employs a mixed methods design, combining qualitative and quantitative approaches to data analysis using NVivo 11 Pro, as illustrated in Figure 1. NCapture, a browser extension for NVivo 11 Pro, was used to compile data into a database file by capturing Facebook posts, *Comments*, *Likes* and other Facebook-related information. Ncapture contains a feature to automatic migrate Facebook data into NVivo in a structured database table. The process of capturing Facebook data for this study occurred on 31 August 2017. Once the Facebook data had been transferred to NVivo, the data was analysed manually for data cleaning and content categorisation. Data was submitted to further cleaning by applying filters to focus exclusively on the dates 1 March to 31 August 2017, after which the data was coded by way of the *node* function, thus permitting qualitative content analysis.

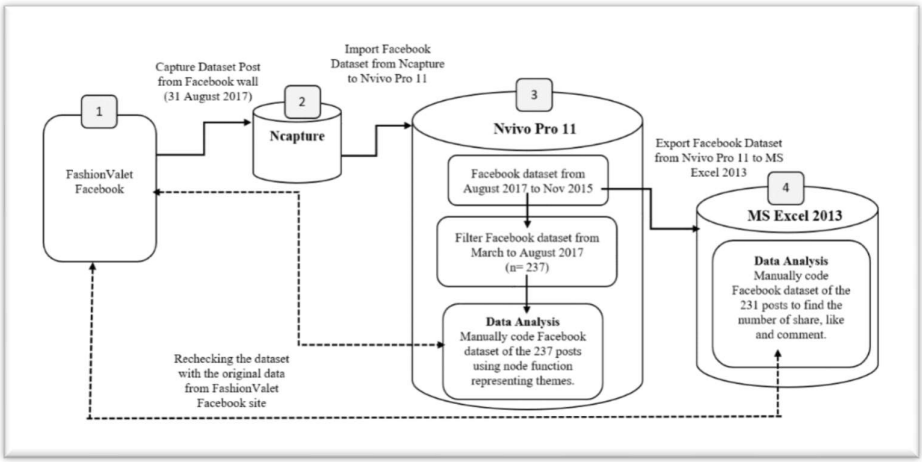

Figure 1. Process of Analysing Facebook Posts

Content analysis of Facebook posts from FashionValet was completed through the coding process, which in this case was completed using the *node* function in NVivo. Following Miles and Huberman [13], this process involved categorising the data using codes and patterns. While content analysis was employed as means of understanding

the Facebook posts, it also allowed the subsequent themes that emerged to be identified and matched according to a predetermined framework [13,14].

The use of Facebook marketing strategies appear in seven of the aforementioned categories: brand awareness, corporate social responsibility, customer service, product awareness, engagement, promotional and seasonal. Classifying posts according these categories means that each post could be assigned to more than one code if necessary. As a form of qualitative analysis, the benefit of this process rests in its ability to allow new coding theme to emerge and for unrelated categories to be omitted while trying to identify FashionValet's Facebook marketing strategy. This process led to the identification of social networking, contest and recruitment as additional elements related to marketing strategies, although no posts were found that related to corporate social responsibility. Posts categorised under 'engagement' were also analysed using quantitative analysis of social media metrics through the number of *Likes*, *Shares* and *Comments*. This method of analysis clarifies the content central of Facebook post to the marketing strategy of FashionValet and its efforts to promote customer engagement. Following these initial qualitative stages of analysis, the NVivo data was imported into MS Excel 2013 for quantitative data analysis by collating the number of posts, *Likes*, *Shares* and *Comments* on each Facebook page for each post in the source data. Descriptive quantitative analysis was performed to elucidate any patterns in Facebook user engagement based on the number of *Likes*, *Shares* and *Comments*. The engagement analysis entailed counting the number of viewers for posts that included video. These indicators yield the popularity trend in Facebook posts.

4 Findings

This section presents the results in the form of descriptive statistics for the content analysis and engagement analysis, including post popularity derived from user click behaviour. This study collected approximately 237 Facebook posts over the course of 6 months. The empirical evidence indicates that posting activity on the FashionValet Facebook page was inconsistent. The highest number of posts was in March, April and May 2017, with 103, 61 and 53 posts per month, respectively. There is a big gap in June when there was only one post for the entire month. The number of posts then increased to 12 in July and decreased to 7 in August. The analysis of media content format indicates that images, specifically photographs, were the most commonly posted format, with 192 images posted during the data collection period. Twenty posts also included photo albums in which users had uploaded multiple photographs simultaneously. In addition, there were 25 posts that included video content.

4.1 FashionValet Facebook Post Strategy

Several marketing strategies appeared from the FashionValet Facebook posts. In this study, a single post could be categorised under more than one marketing strategy. Figure 2 provides some examples of the various categorisations found in the dataset. Moreover, Figure 2 summarises the frequency with which each marketing strategy appears in FashionValet Facebook posts

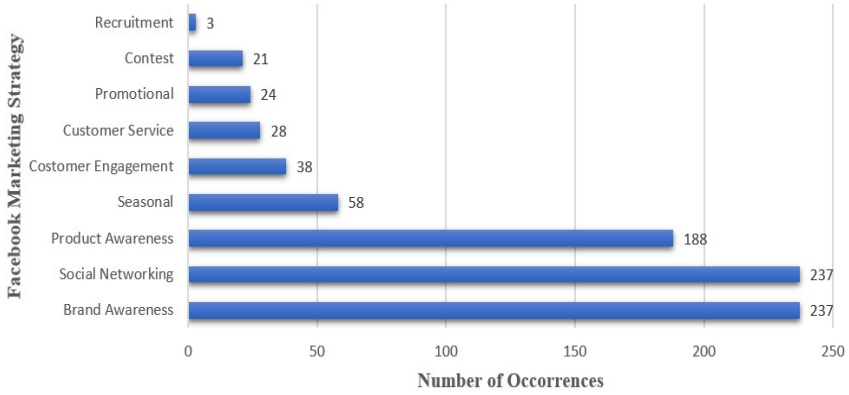

Figure 2. FashionValet Facebook Marketing Strategy.

The most frequently used marketing strategies to be elucidated from FashionValet Facebook posts entailed the use of social networking and brand awareness strategies; in fact all 237 FashionValet Facebook posts identified over the sampling period satisfied these themes. The social networking component of marketing becomes apparent in the use of the hashtag symbol to make connections with customers and business partners. The hashtag makes postings shareable and discoverable on the Facebook platform, and also allows FashionValet to connect with users based on a common theme or interest. This study found that FashionValet had used the hashtag symbol in every one of its posts to signal a keyword or phrase to describe a topic or a theme, such as a campaign, news, trends or branding. For example, every FashionValet post was found to include at least one #fashionvalet tag as a branding device. Other popular hashtags included #fvraya2017 for postings related to Hari Raya festivities, #fvwhatnews for post aiming to inform customers about new product launches or business activities, #FVMEN for posting about products related to men and #FVkids for posts marketing products for kids. In addition, recruitment-related posts carried the #fvcareers tag, while #fvootd was used an acronym for 'outfit of the day', encouraging customers to include this hashtag in their post when they were wearing FashionValet products.

Brand awareness relates to the way in which a company seeks to foster customer awareness and familiarity with its presence. Posts classified under brand awareness need no necessarily contain any actual product information. For example, it is sufficient to simply include the #fashionvalet tag in a post for it to be considered brand awareness. Similarly, posts that seek to promote the *Love Vivy* TV show (Figure 3, P3, P6) were also classified under brand awareness. FashionValet co-founder Vivy Yusof uses her brand as a celebrity in her reality TV show, which is now in its second season. The show revolves around how Vivy manages her busy lifestyle as the co-founder of a business, a wife, mother and daughter, and her relationships with her closest friends. Such posts also fall within the customer service category, acting as a reminder to loyal FashionValet customer to watch the TV show.

Posts inclusive of product awareness are associated with product knowledge, understanding and their presence on the market. In addition to promoting the

FashionValet brand, posts categorised under brand awareness will usually contain the name or an image of a particular product brand. FashionValet strives to establish product awareness for a wide variety of brands under the FashionValet umbrella. One particularly attractive option for listing products on FashionValet's page is the ability to become a part of FashionValet's multitude of promotions and campaigns on social media, including company events, such as the creation of a pop-up store in Brunei and various promotions. Such efforts have the potential to be seen by an almost unlimited number of Facebook users and result in a significant increase in the sale of collections under the FashionValet brand, as shown in Figure 3 (P5) and Figure 4 (P8, P12). Our analysis revealed that approximately 79% (n=188) of postings on the FashionValet Facebook page were about promoting product awareness in some shape or form, thus making this the third most frequently used FashionValet Facebook marketing strategy.

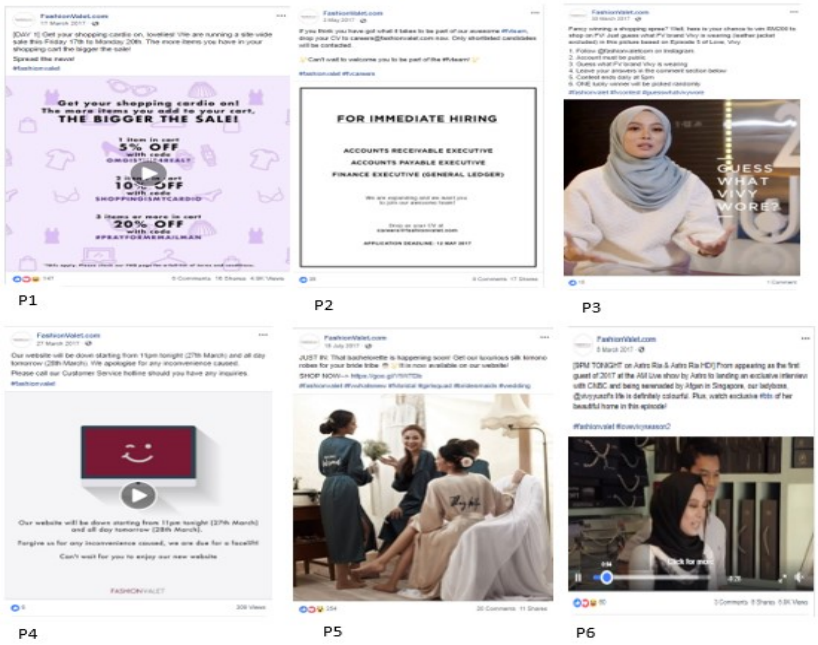

Figure 3. FashionValet Facebook Content Related to Marketing Strategy.

Promotion posts aim at promoting a sale to attract customers to buy a particular product. An example of this type post is shown in Figure 3 (P1). Contest posts are associated with an activity in which participants compete for prizes by accomplishing something that requires knowledge, skill or capability. For example, a post might ask the user to identify what Vivy is wearing in a given episode of her TV reality programme *Love Vivy* (Figure 3, P6). Recruitment posts share information about a job vacancy in the organisation; for example, Figure 3 (P2) describes a position that is available in the accounting and finance department. Such recruitment posts are perhaps the least frequent of all types of posts that reflect the organisation's marketing strategy. Nonetheless, even these recruitments posts are trended among customers, thus taking

advantage of social media to provide an alternative channel for advertising job vacancies within FashionValet.

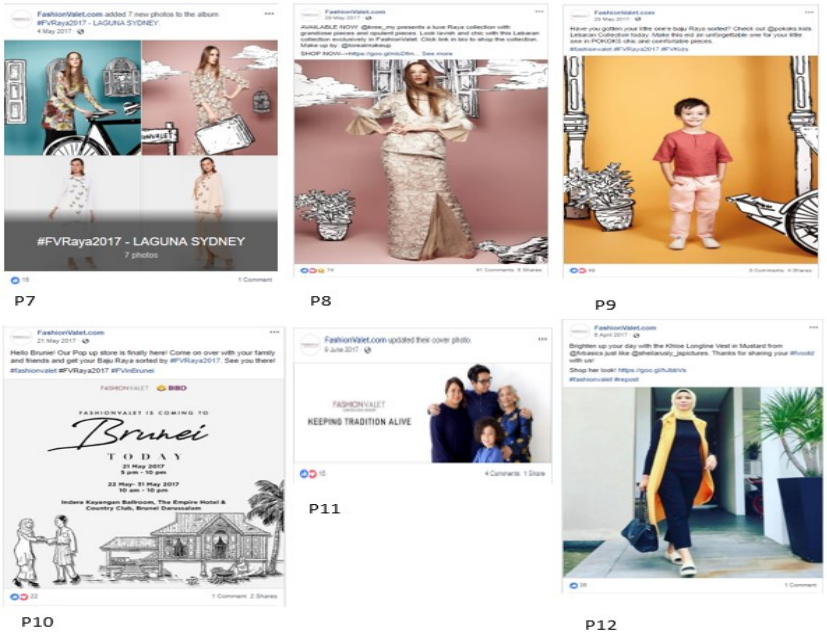

Figure 4. FashionValet Facebook messaging strategy.

The seasonal category applies to posts that mention or that remind users of a particular season or annual event and relate these to a product or brand. During the data collection period, FashionValet was focused on a Hari Raya festive campaign, as reflected in a seasonal marketing post warmly greeting the Islamic holy month of Ramadan with the hashtag #FVraya2017. In addition, the FashionValet Facebook page carried a unique theme that had been created especially for this celebration, incorporating meaningful hand-drawn artwork from a rural area in Malaysia. At this time of the year, FashionValet routinely stocks an abundance of traditional and modern Raya apparel from prestigious local fashion designers. In this sense, most seasonal posts are related to product awareness. This is FashionValet's chief sales period where it is heavily focused on promoting seasonal fashion apparel, referred to as *Baju Raya* in Malaysia. This seasonal content is reflected in Figure 4 (P7, P8, P9, P10). About 24% (n=58) of all posts in the sample period contained Hari Raya seasonally-related product, messages or promotions in photo and video formats.

Customer engagement activities consider the customer as an active participant in Facebook posts. Such posts fundamentally change the role of the customer from being passive recipients of business to being active in the process of adding value to marketing activities. The posts carrying the #fvood and #repost hashtags were grouped under customer engagement because they reflected the actions of customers engaging with FashionValet. Such posts invite customers to become an informal marketing

ambassadors by posting pictures of themselves wearing products they have bought from FashionValet (Figure 4, P12). This activity appears in about 16% (*n*=18) of FashionValet Facebook posts. Customer service posts, on the other hand, provide information, notify or remind customers about events or activities related to FashionValet. Numerous posts during the study period, for example, sought to make customers aware of a FashionValet activity pop-up store in Brunei (Figure 4, P10). Even announcements about the company's website being down fall within the scope of this strategy (Figure 3, P4). We categorised 12% (*n*=28) of all posts during the study period as customer service related.

4.2 Customer Engagement Analysis

This section identifies the customer engagement analysis in Facebook posts. Figure 4 illustrates the pattern of *Likes*, *Shares* and *Comments* in relation to FashionValet Facebook posts over the course of the 6-month study period. The total number of *Likes*, *Shares* and *Comments* indicates popularity or how customers reacted to those posts. The number of Likes, for instance, serves as an indicator of the popularity of particular posts. The data shows that 100% (*n*= 237) of the posts received *Likes* from users, with 4,098 clicks, whereas about 16% (*n*=37) of all posts are shared and 64% (*n*=127) of posts have user comments.

Interestingly, this study found that the most *Liked* photographic post on the FashionValet Facebook page was a post about the launch of a bridal silk kimono robe, receiving 239 *Likes* (Figure 3, P5). This was unexpected as otherwise the most popular photographic posts would have been of seasonal apparel from the #FVraya2018 campaign. The most shared post was about recruitment information for FashionValet, gaining18 *Shares* (Figure 3, P2). These findings would suggest that Facebook postings might be an ideal for ensuring that recruitment advertisement are shared far and wide by other Facebook users. Finally, the most comments (36 in total) appeared in response to a post introducing a festive collection by designer @kree_my for the 2017 Hari Raya collection. These findings show that a post with a marketing message resonated well with customers; as such, this post was classified under both brand awareness and product awareness (Figure 4, P8).

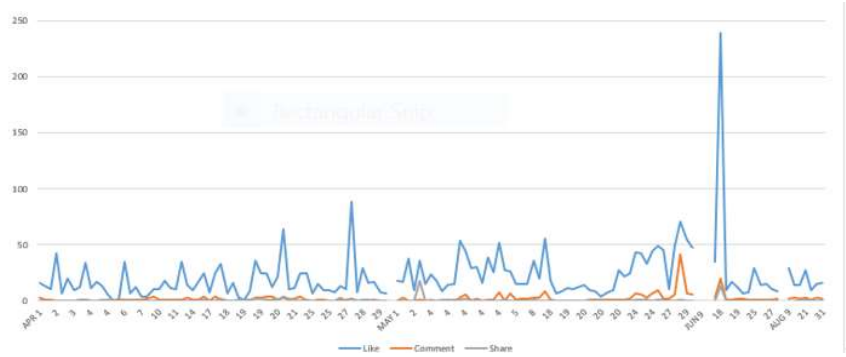

Figure 4. Trends in Customer Engagement with FashionValet Facebook Page.

Further analysis of Facebook user actions under the category of customer engagement show that activities such as sharing and commenting arouse less customer interest. Most Facebook users prefer to view an image or to simply click the *Like* button over having to read an update post. Therefore, it is necessary to determine the best type of content or approach in a Facebook post to engage FashionValet customers.

Regarding video content, previews of the reality TV show about the real life of FashionValet co-founder, Vivy Yusof, gained the highest number of views at 5.9K (Figure 3, P6). This analysis yields strong evidence with which to argue that co-founder Vivy plays a major role in influencing the popularity of post content. *Forbes*, *The New Yorker* and the *BBC* have similarly argued that Vivy plays a major role in the promotion and marketing of FashionValet through her social media account, especially via Instagram and blogs [15–17]. Vivy Yusof is not a celebrity in the traditional sense, having not stared in any theatrical or fictional television productions. Instead, Vivy Yusof claim to fame stems from her prolific postings on social media and regular visible appearances in the social media world.

5 Discussion and Conclusion

This study makes a number of valuable contributions, both for theoretical and practical, to the online fashion industry in Malaysia. It is important for a business to understand and leverage upon the power of social media, both as a Facebook posting strategy and through consumer engagement. Facebook is consistently ranked top among social media platforms. In Malaysia, Facebook provides an opportunity for companies to use this platform as a marketing strategy, thus expanding the range of options SMEs have to engage with their customers over their products. From the theoretical perspective, while many in the global fashion industry have embraced social media marketing strategies, little is actually known about social media content strategies or user engagement behaviour in the Asian context. Worse still, almost nothing is known about how these strategies play out in the Malaysian context. This study is among the first attempts to identify the Facebook marketing strategy of a leading online fashion retailer in Asia. Using the seven categories of Facebook marketing strategy as proposed by Coursaris et al. [5] as the theoretical framework for this study offered a lens with which to explore and identify the characteristics of FashionValet's Facebook posts. This study extends this framework by introducing three new categories: social networking, recruitment and contest.

As social media has grown to become a global phenomenon, Facebook has become an open channel for sharing marketing information. To this end, online fashion retailers, such as FashionValet, aim to avoid being frivolous with their Facebook posts, ensuring that each post serves a deliberate and strategic marketing purpose. The findings of this study indicate that brand awareness and social networking are the main Facebook marketing strategies used by this online fashion retailer. Using the hashtag function with #fashionvalet in Facebook posts, FashionValet ensures that its brand remains shareable and searchable in the Facebook world. FashionValet consistently uses the #fashionvalet tag on all its posts and its customers are well-acquainted with this brand

hashtag, using it to engage with others in the Facebook community. Therefore, the use of the hashtag contributes to social networking activities.

Furthermore, as an online fashion retailer, FashionValet is already active in an area that is only now being recognised for its importance in business—actively engaging and interacting with customers through social media [16,17]. FashionValet has been perhaps ahead of its time in changing the role of the customer from being traditionally passive recipients of information about products or services to actively interacting with the brand. As such, FashionValet transforms the customer in a business partners, adding value to its business activities in the process. This activity is pervasive throughout the brand's customer engagement strategy as the customer participates in promoting the FashionValet product using the #fvootd tag.

Unfortunately, the FashionValet Facebook page scored poorly for user engagement, with the frequency of *Likes*, *Shares* and *Comments* being quite low. To increase its engagement on Facebook, a company must identify an appropriate marketing strategy that not only makes Facebook users focus on reading their post, but also encourages customers to *Like*, *Share* and *Comment* on posts. These user activities results in the customer's friends being notified of their activities while scrolling through their own Facebook pages. Positive customer comments are useful for making the company appear more credible, thus gaining people's trust, and attracting new customers as well as increase sales and loyalty [18].

From a practical perspective, this empirical study provides a useful summary of the various characteristics of a successful Facebook strategy, and elucidates the process of analysing and interpreting customer engagement data from social media. Capturing, analysing and understanding Facebook content can illuminate the strengths and weaknesses of a company's online marketing strategy, help to solve problems and provide new opportunities to improve business strategy [19]. These findings, however, are only the tip of the iceberg when it comes to the myriad of ways in which businesses can make more effective use of social media data. A complex statistical analysis of similar as well as different industries would significantly enrich the generalisability of the findings.

Acknowledgement

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Bayes goes to the Cinema

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Abstract. This paper introduces a methodology to combine relevant *factors* that guide the choice of cinemas' users towards a certain type of movie, as well as to intercept the *user profile* for specific marketing campaigns. To this end it has been employed a *Bayesian belief network* that reveal to be useful for coding *tacit knowledge* emerging from experience. BBNs have been applied to a dataset provided by a movie distribution company that operates in multiplex cinemas throughout Italy, that collects users' answers about their personal preferences, from various multiplexes on the national territory. Indeed, SMEs hold data with particular types of features that are not contained in general-purpose datasets but which are necessary for their specific business decisions, without being, therefore, experts in analytical or computer science subjects. Through the mediation of the *Bayesian network* mechanism the organisation brings together updated *preferences* from a collective of customers that express their tastes and, as such, contributing to a *value co-creation* initiative.

Keywords: Value Co-creation · Bayesian networks · SME organisation · Opinion polling · Management information system.

1 Introduction

The work introduces preliminary experimentation, concerning an agent who, behaving in a *Bayesian* way, chooses the type of movie to watch. To this end, a *Bayesian network* is trained on *data* coming from interviews given to users of cinemas.
Each user has been subjected to a series of questions, both demographic and specific questions, about their cinematographic tastes, and more general cultural ones. More specifically, users were asked to answer questions such as "social channels frequented", "kind of favorite movie", "criteria of choice of the cinema", and, more in general, cultural tastes such as "average number of books read in a year", "average number of museums visited in a year" or "which activities organised and promoted by the interviewer are you most interested in". Table 1

gives a summary of all *factors* contained in the dataset generated by the survey.[4] The aim of the experimentation is to identify the combination of relevant factors that guide the choice of the user towards a certain type of movie, as well as to intercept the *user profile* for specific marketing campaigns. In this sense, the *Bayesian network* represents a suitable and friendly methodology, since, with the same performance compared to other AI algorithms, they lend themselves to an easy reading of the results even by users that are not experts in the computer science sector. In fact, the combination of relevant *factors* that drive to the user's final *decision* on the preferred movie, can be read as *paths* on the networks or translated in terms of simple *if-then* rules [4, 16].
On the whole such a kind of interaction, among *customers*, that answer the questionnaire, and the *SME*, that tries to capture their preferences through the *Bayesian network*, represents a *value co-creation* initiative [17] thanks to the employment of a AI inspired *information system* [12]. In fact, through the mediation of the *Bayesian network* mechanism the organisation brings together updated *preferences* from a collective of customers that express their tastes using the online questionnaire at the organisation website. Netflix is one of the first business cases of using predictive analytics to cultivate and engage new customers through focused advertising of the right movies for their customers. In this sense, even more interesting, Netflix also represented one of the first examples of *value co-creation*, since customers are actively involved in the provision of services related to its core business [18] through the employment of a recommendation engine just based on predictive analytics.
Nowadays, however, predicting which profiles of people could be interested in specific movie genres, also represents an objective for SMEs of the movie-rental market.
More and more SMEs, which collect data concerning their customers' behaviours [7], need analytical models and techniques able to innovate internal *decision-making* processes where customers may play a chief role [1, 6].
SMEs hold data with particular types of features that, generally, are not contained in general-purpose datasets, such as *MovieLens*, but which are necessary for their specific business decisions, such as, for instance, demographic information. On the other side, news and media websites also need these models to improve content-based strategies towards their followers when suggesting movie reviews. On the whole, predictive analytics methods seem to be gaining more ground and attention to the organisation of the new companies operating on the web [5].

2 Related work

In their work, [19] proposed a *predictive model* that can be used by SMEs, wishing to use their own data to keep customers and provide them appropriate

[4] The survey was administered by *Blu&Blu Network s.r.l.* movie distribution company that operates, mainly, in Italy, in partnership with a *Y Media Group Ltd*, operating in Italy and UK.

movies suggestions. To this end, the authors employed a classification methodology to identify *demographic*, *behavioral* and *social* features [14].[5] The dataset employed in their experiments is made of 1100 observations about movie genres. The dataset contains tastes for 11 types of movies, 22 personal *feature* and 5 demographic *features*. In their intensions, the authors of the proposed model aim at predicting genre preferences based on geographic *factors* (e.g., city or state). Another specific issue addressed by this work is that it analyzes the factors of survey respondents who like specific types of movies (e.g., comedy). Nowadays much information, about customer preferences, are explicitly gathered employing surveys to respect customer privacy as well who can thus authorize the processing of their data from time to time. Experiments, performed employing two different type of machine learning algorithms (i.e., *logistic regression* and *Gaussian Kernel SVM*), show the plausibility of the methodology for movie genre prediction. From the experimentation emerged that *geographic* factors contain more information about movie preference concerning *sex classification* factor, which usually is considered more informative. Moreover, *geographic* factors seem to play a chief tole to predict customer movie genre preferences (i.e., comedy movies).
An approach to constructing users' movie preferences using *Bayesian networks* has been proposed in [13]. The authors employed both users' context and user personalities traits with the aim of recommending and promoting movies. Overall, the experimentation exploited a set of data obtained employing ad-hoc user questionnaires that are administered to 2153 subjects, described by 401 attributes. The attributes used are divided into two broad categories, one that expresses the *user situation* while another expressing *user impression*. The results showed that *situation* attributes were both effective and promising.
The approach that has just been introduced is the one that is closest to ours and to the types of data employed. The authors, however, have introduced a series of changes to the *Bayesian network* that proved to be extremely expensive. Moreover, the high number of features used in the description of users, produced a significant drop in performance. Furthermore, such a massive use of features risks significantly limiting the involvement of customers and, consequently, their contribution to *value co-creation*. The aim of our approach, on the other hand, is to identify the most relevant *factors* used by customers, in order to re-propose them in subsequent interactions and to facilitate the SME's task in suggesting movies in an increasingly precise and effective manner, without the marketing decision-makers have to resort to complicated technical analysis. Finally, in the approach proposed below, a strong attention was paid to factors related to the use of social media and to the geolocation of supply, factors that were not considered in the approaches analysed in this section.

[5] In this context, we employ *feature* and *factor* as synonyms, although, as known, *factor* is a term more used in the *Monte Carlo* methods (e.g., *Factor analysis*, *SEM*, and so on), while *feature* is typically used in the context of *machine learning*

3 Bayesian networks' paradigm

The *Bayesian belief network* (BBN) paradigm has been extensively used in systems dealing with *uncertainty* of input data and *incomplete knowledge* [11] [9] [15]. A *BBN* is a type of Directed Acyclic Graph (DAG) that encodes the causal relationships between stochastic variables. It gives a visual representation of conditional probabilities of the data. The *nodes* represent the stochastic variables, while the *arcs* encode the probabilistic dependencies between nodes. An arc represents a unidirectional causal relationship between the parent node and the child one.
Many factors can generate uncertainty. For instance, the *expert knowledge* could be insufficient, data could be affected by errors, or some of them could be missing. The BBN is a probabilistic inference tool with the advantage that each node of the network can be treated either as an input or an output.
BBNs are particularly useful in cases where direct observation or evidence is not available [8]. A set of probability values form the conditional probability table (CPT) associated to each node of the BBN. A BBN can be used for making a diagnostic, causal or mixed inference. The conditional probability can be defined by using *Bayes theorem* according to the *conditional probability* of x given y according with the following equation:

$$P(x|y) = \frac{P(y|x)P(x)}{P(y)} \tag{1}$$

where x and y are events while $P(x)$ and $P(y)$ are the occurrence probabilities of x and y, $P(x|y)$ and $P(y|x)$ are the conditional probability of x given y and the conditional probability of y given x respectively. BBNs are particularly useful for coding the knowledge of an expert in a domain; in particular, the tacit knowledge that arises from experience, to answer "what-if" questions by modeling cause and effect.

4 Data and Methods

Data have been provided by *Blu&Blu Network s.r.l.*, a movie distribution company that operates in multiplex cinemas throughout Italy. The *dataset*, made of 2069 records and 25 *factors*, is the product of a questionnaire that collects users' answers of the various multiplexes on the national territory. Table 1 gives a summary of all *factors* contained in the dataset.

From data above it has been induced a BBN by using the *Genie Tool* [10] which executes the *Bayesian Search structure learning* algorithm described by [3] and refined by [2]. The tool implements a *hill climbing procedure*, guided by a *scoring heuristic*, with random restarts. The result graph is illustrated in Fig.1.

Exploiting the BBN and setting an evidence on the fact that a person is a *male*, it can deduced that the main *source of information* on movies is "the Web" with a probability of 60%, while this percentage is 58% if we set the gender to *female*. Furthermore, *males* prefer "Thriller" (18%), "Science fiction" (16%)

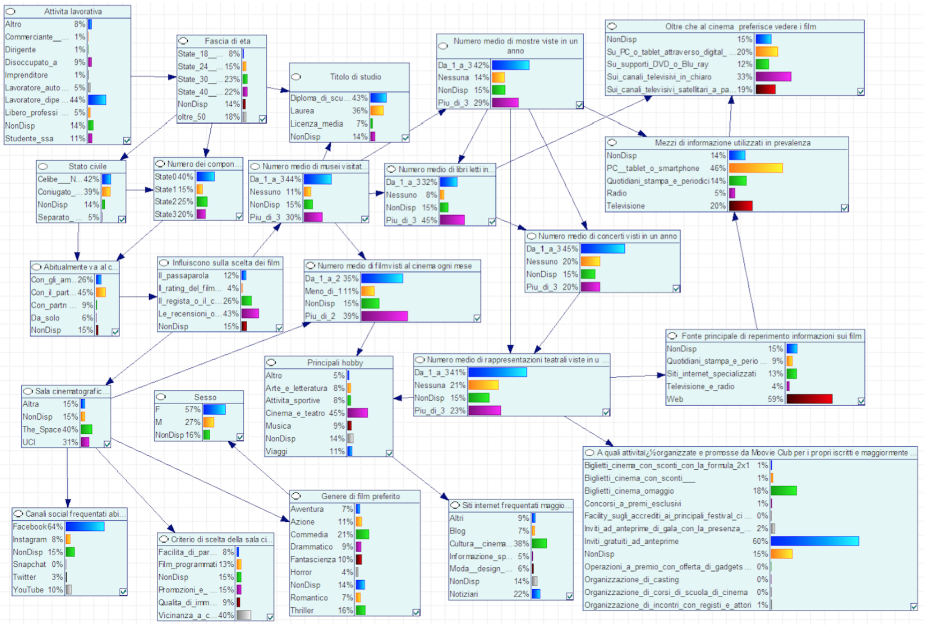

Fig. 1. The Bayesian Belief Network induced from data. Labels are in Italian language

genres of movie, while females prefer "Comedy" (25%), followed by "Thriller" (15%) movies.

Another example of inference is given by setting the evidence of the variable *"Social media used"* (Fig.2) on "Instagram": we can observe that we have a relevant modification on the following variables: there is an increase of probability for "The Space" as "Movie theater" from 40% to 51%; for *"average number of movies for month"* there is an increase from 35% to 39% for "1 or 2" and "more than 2" from 39% to 44%; the *"Yearly average number of exhibits visits"* raises from 42% to 47% for "1 to 3" and "more than three" raises from 29% to 33%; the average number of concerts attended in one year grows from 45% to 50% for "one to three times", while "more than three" increases from 20% to 22%. For the *"Qualifications"* variable we note an increase from 43% to 48% for the *"Diploma degree"* and an increase from 36% to 39% for the *"Laurea"* degree; for the *"Job"* we observe that "employee" grows from 44% to 48%, while we note that we have an increase of probability of being interested to free invitation to previews from 60% to 67%.

5 Conclusion

Nowadays more and more SMEs hold data with particular types of features that are not contained in general-purpose datasets but which are necessary for their specific business decisions, without being, therefore, experts in analytical

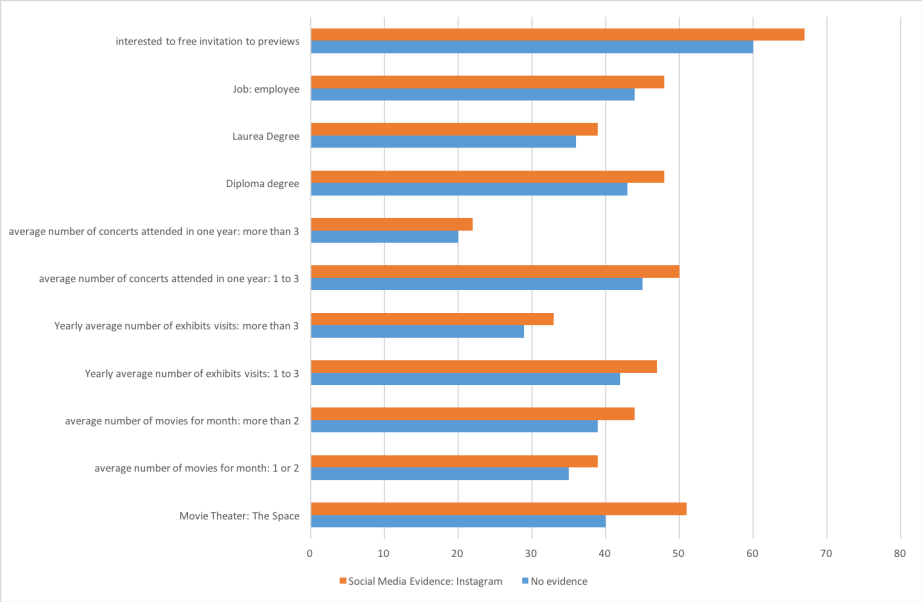

Fig. 2. The main profile results obtained by setting as an evidence "Instagram" as the main social media used by the user (Orange bars) with respect to the BBN with no evidence set at all (Cyan bars).

or computer science subjects. The methodology proposed in this paper seems to be suitable to identify a combination of relevant *factors* that guide the choice of cinemas' users towards a certain type of movie, as well as to intercept the *user profile* for specific marketing campaigns. To this end it has been employed a *Bayesian belief network* that reveal to be useful for coding *tacit knowledge* emerging from experience, in the form of *what-if* questions by modelling *causes* and *effects*. BBNs have been applied to a dataset provided by a movie distribution company that operates in multiplex cinemas throughout Italy, that collects users' answers about their personal preferences, from various multiplexes on the national territory. In this case, a company marketing officer can use the rule generated by the BBN to decide where and how to target his next marketing campaign, such as sponsorship promotion, and so forth. All this in the form of very simple *rules* that do not require any technical knowledge. For example, users who frequent the movie theatre "The Space" are those who use more Instagram as social media. Therefore, any type of marketing or sponsorship campaign that regards that segment of users is preferable to be disseminated through this social media. Since customers are actively involved in the providing their preferences to the organisation that, on his side, through the employment of a *Bayesian network* automatically extract a model under the form of *paths* or *if-then-rules* that can be exploited by their management, the proposed approach contribute to co-create value in the overall business process.

6 Acknowledgments

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Table 1. Table contains the *factors* employed in the movie dataset

Type of factor	Factor
Demographic	*Gender*
Demographic	*Age range*
Demographic	*Marital status*
Demographic	*Degree of study* Text follows
Demographic	*Job*
Demographic	*# of family members*
Behavioural	*Most frequented websites*
Behavioural	*Social channels frequented usually*
Behavioural	*Information channels used prevalently*
Behavioural	*Main hobbies*
Behavioural	*Favorite movie genre*
Behavioural	*Reference cinema multiplex*
Behavioural	*Cinema choice criterion*
Behavioural	*Average # of movies x month*
Behavioural	*Presence at the cinema*
Behavioural	*Factors influencing movies' choices*
Behavioural	*Movies source of information*
Behavioural	*Average # of books read yearly*
Behavioural	*Average # of concerts seen yearly*
Behavioural	*Average # of exhibitions seen yearly*
Behavioural	*Average # of museums visited yearly*
Behavioural	*Average # of theatrical performances seen yearly*
Behavioural	*What activities organized and promoted are more interesting?*

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Relating Big Data Business and Technical Performance Indicators

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Abstract. The use of big data in organizations involves numerous decisions on the business and technical side. While the assessment of technical choices has been studied introducing technical benchmarking approaches, the study of the value of big data and of the impact of business key performance indicators (KPI) on technical choices is still an open problem. The paper discusses a general analysis framework for analyzing big data projects wrt both technical and business performance indicators, and presents the initial results emerging from a first empirical analysis conducted within European companies and research centers within the European DataBench project and the activities of the benchmarking working group of the Big Data Value Association (BDVA). An analysis method is presented, discussing the impact of confidence and support measurements and two directions of analysis are studied: the impact of business KPIs on technical parameters and the study of most important indicators both on the business and on the technical side, for specific industry sectors, with the goal of identifying the most relevant design and assessment criteria.

Keywords: Big Data, Benchmarking, Key Performance Indicators

1 Introduction

The use of big data in organizations implies numerous decisions on the business and technical side. While the assessment of technological choices has been studied introducing technical benchmarking approaches, the study of the value of big data and of the impact of business key performance indicators (KPI) on technical choices is still an open problem. This is mentioned as an IS research challenge: "What design theories do we need to guide big data architectures based on organizational and industry-level contexts?" in [1], discussing research challenges for Big Data.

Giving an answer to this question is one of the goals of the H2020 DataBench research project, funded by the European Commission, started in January 2018. The

aim of the project is to provide objective, evidence-based methods to measure the correlation between Big Data Technology (BDT) benchmarks and business benchmarks for an organization and to demonstrate return on investment, developing tools to support this analysis. The identification of adequate benchmarks can support Value management practices in an organization, as described in [2], and in particular in structural practices such as the Value management office and in process practices, namely benefits management and risk management.

The paper discusses a general analysis framework for analyzing big data projects, discussing both business performance indicators and IT technical indicators emerging from the analysis of ongoing European research projects on Big Data, and presenting the first results emerging from an initial empirical analysis conducted within European companies and research centers within the European DataBench project and the activities of the benchmarking working group of the Big Data Value Association (BDVa)[1]. The issue of relating IT performance and measuring value [2] and managing value [3] of information systems has widely been debated in the literature, in which studies deriving indicators based on case studies are proposed.

In this paper, an analysis method is presented, discussing the impact of confidence and support measurements and two directions of analysis are studied: the impact of business KPIs on technical parameters and the study of most important indicators both on the business and on the technical side, for specific industry sectors, with the goal of identifying the most relevant design criteria. With reference to the classification presented in [3], as our approach is oriented to consider indicators to evaluate Big Data systems benchmarks, we consider indicators with a Business Operations focus, including external service delivery and IT operations indicators.

While IT technical indicators have been analyzed in the literature [3], and can be derived from reference models, such as the ones introduced by BDVa in [4] and NIST in the NIST Big Data Reference Architecture) [5], performance indicators from the business perspective still need further investigation in this area.

As discussed in [6], starting from empirical evidence, industries in the IT sector and highly competitive industries are able to extract value from Big Data, while in other industry groups there is a need to find a measurable impact of this technology.

The goal of the paper is to define business and technical indicators and to study how to find relationships among indicators. The main aim is to profile industry sectors wrt Big Data Analytics (BDA) and to find the significant indicators for assessing its value to organizations.

The developed methodology is based on desk analysis and a questionnaire to collect data from the European research space, in particular from participants in Projects on Big Data within the Private-Public-Partnerships (PPP) in 2014-15[2]. The questionnaire has been developed within the DBVa Benchmarking working group with the goal of collecting information about both business and technical aspects.

The paper is structured as follows. Section 2 introduces a first new framework developed within DataBench to classify business performance indicators. Then, in Section 3, the technical indicators derived from the analysis of existing reference architectures are illustrated. Section 4. describes the methodological approach followed

[1] http://bdva.eu/

[2] https://ec.europa.eu/digital-single-market/en/big-data-value-public-private-partnership

to analyze the results of the questionnaire to collect data about ongoing projects and Section 5 presents and discusses the first conclusions that can be derived from the analysis.

2 Business Performance Indicators

The literature on the relationship between IT (information technology) and business benefits is vast. A largely accepted assumption of this literature is that if a company makes a major investment in IT, the benefits of the investment should be measurable with a business performance indicator [2]. IT is attributed an important organizational role and IT's impact is considered pervasive [7], tangible [8] and measurable with both financial and non financial business performance indicators, often referred to as business KPIs (key performance indicators, cf. [9]). The next section provides a classification of business KPIs, grounded on previous literature.

2.1 Categories of Indicators

Business KPIs have been classified in several different ways in previous literature. A fundamental distinction is made between financial, or economic, and non financial KPIs [2]. There is general agreement that a correct evaluation of benefits from a major IT investment should be based on multiple KPIs. For example, authors in [9] have introduced the concept of *balanced scorecard* as a basis for the design of management control dashboards in the design of executive information systems. Similarly, [10] considers the combined use of financial and non-financial KPIs as more effective in the assessment of strategic decisions.

In DataBench, we focus on use cases of big data & analytics projects and aim at the assessment of benefits at a use-case level. An example use case could be the application of machine learning techniques in loyalty marketing and a corresponding benefit could be the reduction of customer churn. In turn, the measurable business KPIs that can be associated with a reduction of churn could be customer satisfaction and revenue growth. In DataBench, we are conducting a desk analysis to collect and classify big data & analytics use cases. So far, we have classified 75 use cases in 9 different industries. The next section discusses how these KPIs represent a fundamental dimension of the more general framework that we have used to classify use cases and to contextualize the measure of business KPIs.

2.2 Modeling Business Indicators

Figure 1 shows a table where different dimensions represent characteristics of use cases that have to be assessed in order to support the high-level design of the technology architecture and the selection of corresponding technical benchmarks (see Section 3). These characteristics have emerged from the analysis of a total of 75 big-data projects based on our preliminary desk analysis. For example, the *industry* has emerged as an important factor driving high-level technical choices and the corresponding selection of technical benchmarks. We have observed that in the retail industry, the adoption of

non-relational technologies is not seen as a business enabler, as retail data are mostly structured and data schema changes are not frequent. Consequently, technical benchmarks designed for non-relational technologies are less (or not) needed in retail, compared to other industries, such as financial services, where handling documents and applying varying tag sets with semantic technologies can result in frequent data schema changes.

Current work in the DataBench project is focusing on completing the classification of big data project characteristics based on the desk analysis and experimenting them in field studies. As shown in Figure 2, business indicators are grouped in characteristics. Business indicators represent a classification dimension that has a relationship with the choice of technical benchmarks that is mediated by other big-data project characteristics. A project classified with a multi-dimensional model is likely to use specific technical benchmarks. In turn, the correct design of the technology architecture aided by the technical benchmarks represents an enabler of specific business KPIs.

Industry	Big Data Maturity	KPI	Scope of Big Data & Analytics	Data User	DB & Analytics Application	Size of Business	Data size	Datasource
Finance	Currently using	Cost reduction	Decision optimization task	Data Enterpreneurs	Sales	5000 or more	Gigabytes	Distributed
Manufacturing	Piloting or implementing	Time efficiency	Data driven business processes	Vendors in the ICT industry	Customer service & support	2500 to 4999	Terabytes	Centralized
Retail & Wholesale	Considering or evaluating for future use	Product/service quality	Data oriented digital transformation	User companies	IT & data operation	1000 to 2499	Petabytes	
Telecom/ Media	Not using and no plan to do so	Revenue growth			Governance risk & compliance	250 to 999	Exabytes	
Transport/ Accomodation		Customer satisfaction			Product management	50 to 249		
Utility/Oil&Gas/ Energy		Business model innovation			Marketing	10 to 49		
Professional services		Lauch of new products and/or services			Maintencance & logistics	less than 10		
Governamental/ Education					Product innovation			
Healthcare					HR & Legal			
					R&D			
					Finance			

Fig. 1. Big data business indicators

3 Technical Indicators

Figure 2 shows the mediated relationship between technical benchmarks and business KPIs discussed in the previous section. Different technical benchmarks evaluate different technical features and provide different output metrics, accordingly. The goal of DataBench is to understand the decision variables that should be considered to choose the right technical benchmark, which, in turn, can help delivering business benefits. Section 3.1 reports a classification of technical benchmarks and related output metrics. Section 3.2 shows a preliminary technical decision framework.

Fig. 2. The mediated relationship between business KPIs and technical benchmarks.

3.1 Categories of Benchmarks and Output Metrics

Figure 3 shows a matrix positioning the Big Data benchmarks being developed in [11] according to different criteria defined in the BDVA Reference Model [4]. On the left (in blue) are listed the different industry application domains, data types and technology areas. On the bottom (in green) in a release time order all the main Big Data benchmarks are listed. Different technical benchmarks show a clearly different focus in terms of features that are benchmarked. There is no complete benchmarking suite and companies have to make a decision on which benchmarking tool is best suited to their application purposes. However, there is no clear correlation between the characteristics of the technical benchmark and the architectural choices that the company should make, which, in turn, depend on the characteristics of the big-data project.

3.2 Modeling Technical Decision Variables

Figure 4 represents a first attempt developed in DataBench to classify technical indicators to select key decision variables in the choice of the technical benchmark. In addition to characteristics related to the output metric and the system, the nature of the task to be accomplished seems to represent a key decision variable. For example, in some cases companies have very complex predictive analytics to execute and need to make sure that the algorithm that they choose is efficient at using available computing capacity. In other cases, they are concerned with more traditional benchmarks evaluating the response time of a DBMS at retrieving information from large SQL tables with a different schema design. As for business indicators, the table provides a classification of indicators in characteristics (from Metrics to Platform features).

4 Relating Indicators

The objective of this section is to define systematic analyses that have to be performed in order to gather evidence about the importance of single indicators in Big Data systems and their relationships. The analysis also aims to profile the gathered information by focusing on some specific aspects, such as for instance industry sectors, or specific technical or business characteristics.

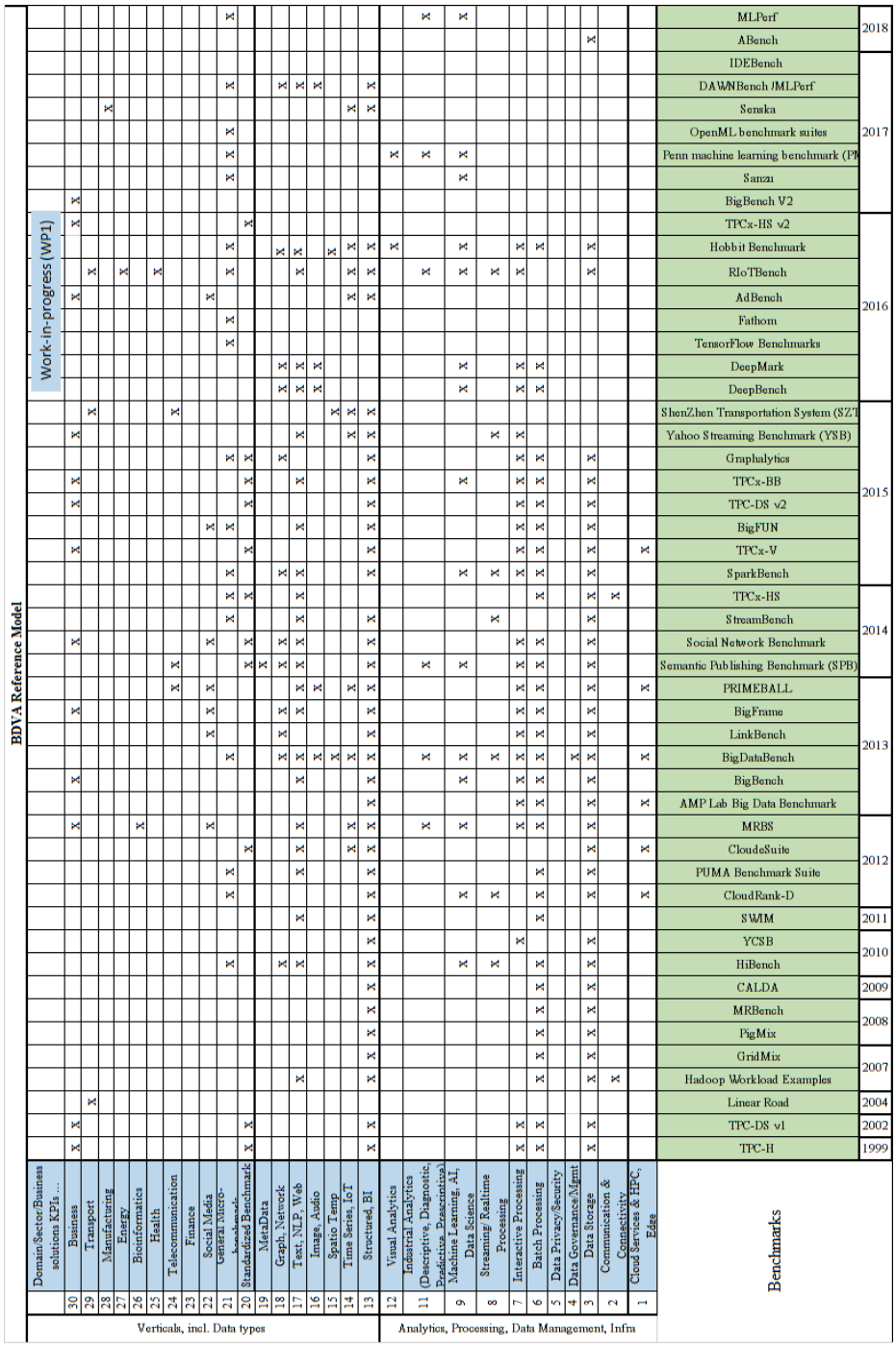

Fig. 3. Classification of technical benchmarks (source: [11])

Metrics	Data Types	Benchmark Data Usage	Storage Type	Processing Type	Analytics Type	Architecture Patterns	Platform Features
Execution time/ Latency	Business Intelligence (Tables, Schema…)	Synthetic data	Distributed File System	Batch	Descriptive	Data Preparation	Fault-tolerance
Throughput	Graphs, Linked Data	Real data	Databases/ RDBMS	Stream	Diagnostic	Data Pipeline	Privacy
Cost	Time Series, IoT	Hybrid (mix of real and synthetic) data	NoSQL	Interactive/(near) Real-time	Predictive	Data Lake	Security
Energy consumption	Geospatial, Temporal		NewSQL/ In-Memory	Iterative/In-memory	Prescriptive	Data Warehouse	Governance
Accuracy	Text (incl. Natural Language text)		Time Series			Lambda Architecture	Data Quality
Precision	Media (Images, Audio and Video)					Kappa Architecture	Veracity
Availability						Unified Batch and Stream architecture	Variability
Durability							Data Management
CPU and Memory Utilization							Data Visualization

Fig. 4. Characteristics of technical benchmarks.

In this section, the analysis process is delineated, while in next section the first outcomes of the DataBench project, obtained combining desk analysis and the results of an online questionnaire, are illustrated.

In the following, N will indicate the number of collected responses. Multiple responses for an indicator are possible. In this section, indicators are the possible values for each category (e.g., small, medium, large for size category are considered as three indicators).

POS(Ii) indicates a positive answer to one value of an indicator, POS(I1,...,In) indicates the number of positive answers to a question in the questionnaire, where POS(I1,I2) indicates positive answers to both indicators I1 and I2.

4.1 Identifying Common Goals in Big Data Projects

A first goal is to identify the most popular indicators in Big Data projects. For each category, the most popular answers will be identified. There are two elements to be considered: the percentage of answers supporting the indicator within a decision variable and a threshold to establish when the percentage is significant to support the indicator. To this purpose two formulas are used:

$$confidence: POS(Ii) \,/\, \sum 1, n \; POS(Ii) \qquad (1)$$

to indicate the significance of the indicator within a decision variable with n possible values and

$$support: POS(Ii)/N \quad (2)$$

to indicate the support for a given indicator, i.e., the percentage of positive answers supporting the indicator on the collected data.

4.2 Analyzing Dependencies Among Indicators

The goal of this analysis is to capture significant dependencies among pairs of indicators. The analysis is therefore based on POS(Ii, Ij) values.

Depending whether the interest is in analyzing the impact of indicator Ii on Ij (or vice versa), the relative importance for the indicator of interest is assessed with the following formula:

$$cross - significance: POS(Ii, Ij) \; / \sum 1, n \; POS(Ii) \quad (3)$$

(if we focus on Ii, otherwise the sum is over Ij), where Ii and Ij are indicators belonging to different types of characteristics.

This analysis is useful to find significant relationships between indicators belonging to different categories, e.g., to assess if a given business indicator influences technical choices, or if given technical choices are more common in given business situations. An example is shown in Figure 5, derived from the field analysis illustrated in Section 5 (in this first questionnaire also margin growth was considered, which is been considered as a more detailed indicator linked to cost reduction and revenue growth and therefore not shown in Figure 1.

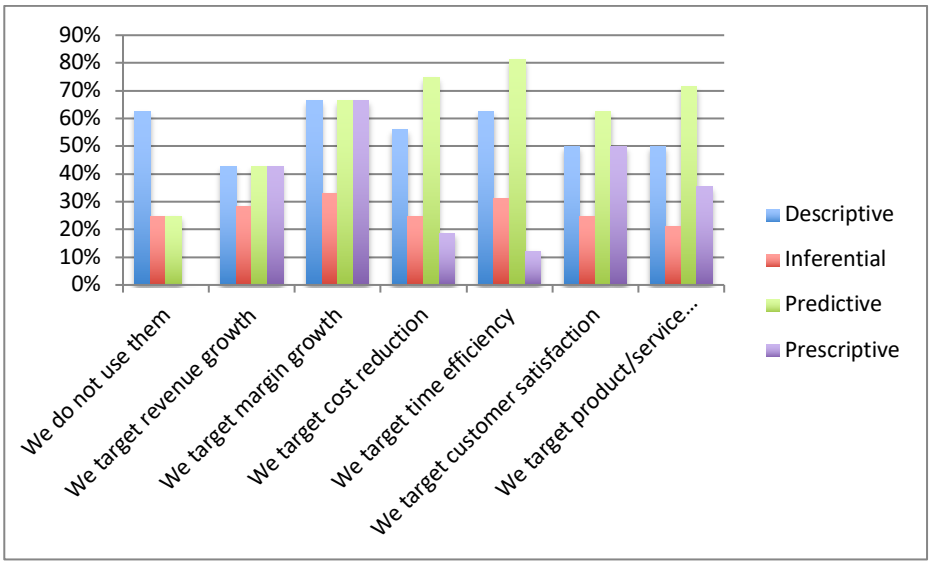

Fig. 5. Example of cross-significance analysis business KPI (x-axis) vs Analysis type (y-axis)

4.3 Profiling on a Pivot Indicator

The analysis techniques presented above can be used to focus on one characteristic and analyze its implications on other characteristics.
For instance, starting from the 'Industry' characteristic, each industry type can be profiled, selecting all most significant indicators in other characteristics for such industry type.

The analysis is based on the use of one indicator Ii as the pivot indicator, and identifying the cross-significance for the other indicators. The most significant for each category are selected as representative indicators in the profile, based on a threshold. The threshold can be set considering the significance and precision of the indicator in the data set.

5 Results from a First Field Analysis

In the following, we perform our analysis considering some of the above-mentioned indicators, analyzing the results of a questionnaire on business, technical, and benchmarking aspects developed within the BDVa Benchmarking group and for which answers were collected in the period March-May 2018. Respondents where mainly participants in European PPP Big Data projects, for a total of 36 responders, representing 37 different projects. The questionnaire is synthetically reported in the appendix.

In the questionnaire, we analyzed the most important indicators using the profiling technique illustrated in Section 4.3, and the indicator category [D5] "What are your Big Data application domains", which can assume the following values:
Energy, Financial Services, Manufacturing, Construction, Food/Agriculture, Retail, Wholesale/Professional services, Transport Services, Public Administration, Healthcare, Education, Telecom/IT/Media, Utilities.

We present in Figure 6. the profile obtained for the Manufacturing domain, selecting the indicators that have high confidence in the domain, i.e., for which most of the respondents in the sectors indicated an interest.
From the analysis illustrated in Section 4.1, we also derive that some of these indicators are generally significant across industry sectors, e.g., the answer indicating compliance wrt business requirements and specifications for D10 is common to most sectors.

6 Concluding Remarks

In this paper, we have discussed our preliminary results in the definition of a framework to tie the use of technical benchmarks to business indicators. The assumption underlying this study is that technical choices play a strategic role in big data projects and the use of technical benchmarks is of pivotal importance to help architectural choices. The link between technical benchmarks and business indicators can be used in both directions, to help the selection of the right technical benchmarks and to maximize business KPIs with a correct interpretation of the results of technical benchmarking. In the DataBench project, the framework will help the selection of technical benchmarks with a toolbox that will embed key decision variables and will either integrate or link to the most appropriate technical benchmarks. On the other hand, the results of technical benchmarking activities will be tied back to business KPIs and benefits with in depth case studies.
Results from the questionnaire support the assumption that there is a relationship between technical benchmarks and business KPIs. They also indicate that this relationship is mediated by other variables, such as the industry where a company operates and the specific characteristics of the big data project that is performed. In this research we started from a desk analysis and an initial questionnaire to explore the field, in our future research we will systematically analyze these indicators validating them with an extensive survey and selected case studies in order to design our decision framework for Big Data benchmarking.

MANUFACTURING [7 respondents]

- [D10] What are your big data benchmarking goals/plans?
  - **Check whether an implementation fulfils given business requirements and specifications.** [86%]
- [D11] Which aspects of Big Data are you benchmarking or planning to benchmark? (ref. BDV Reference Model)
  - **Data Analytics** [100%]
  - **Data Management** [71%]
  - **Data Processing** [71%]
- [D12] What kind of data are you using/planning to use?
  - **Real Data** [86%]
  - **Hybrid** [86%]
- [D15] What type of Data Storage (Storage/Querying/Discovery) are you benchmarking/considering?
  - **Graph Stores** [67%]
  - **NoSQL** [67%]
- [D16] What is the most important type of Data Processing in your platform?
  - **Interactive/(near) Real-time processing** [71%]
- [D17] What types of data problems are you tackling?
  - **Descriptive** [71%]
  - **Predictive** [86%]
- [D18] What types of machine learning approaches do you typically use?
  - **Supervised** [86%]
- [D19] Which modelling techniques do you typically use?
  - **Deep Learning** [67%]
- [D20] What types of data are stored and processed in your system/platform? (Ref. BDV Reference Model types)
  - **Time Series including IoT Data** [86%]
- [D21] What are the technical key performance metrics that you (want to) measure in your system/platform/service?
  - **End-to-end execution time (Runtime)** [100%]
  - **Throughput** [67%]
- [D22] Which of the following qualitative features are important for your application/platform?
  - **Fault-Tolerance** [71%]

Fig. 6. Profiling key performance indicators in the Manufacturing domain

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Appendix - Benchmarking Big Data Benchmarks Questionnaire Structure

The structure of the Big Data Benchmarking WG questionnaire is as follows:

General questions

- What is your current role/position?
- Are you participating in EU research projects? If yes, which ones?
- Are you affiliated with an organization? If yes, which one?
- Which societal challenges do you target?
- What are your Big Data application domains?
- Do you use business indicators to measure the performance of your big data & analytics initiatives?
- Are your big data & analytics in real-time and integrated with business processes?
- In which role do you perform benchmarking?
- Are you currently evaluating software using benchmarking technologies?
- What are your big data benchmarking goals/plans?
- Which aspects of Big Data are you benchmarking or planning to benchmark? (ref. BDV Reference Model)
- What kind of data are you using/planning to use?
- Which dataset sizes do you target in your application(s)?

Additional technical questions

- What type of Data Storage (Storage/Querying/Discovery) are you benchmarking/ considering?
- What is the most important type of Data Processing in your platform?
- What types of data problems are you tackling?
- What types of machine learning approaches do you typically use?
- Which modelling techniques do you typically use?
- What types of data are stored and processed in your system/platform? (Ref. BDV Reference Model types)
- What are the technical key performance metrics that you (want to) measure in your system/platform/service?
- Which of the following qualitative features are important for your application/platform?
- What are the key technologies that you are using in your big data infrastructure? For example, Big Data platforms such as Cloudera, HortonWorks, MapR or others offering Hadoop distributions, Spark, Flink, Storm or similar for batch and stream processing, Hive, Spark SQL, Presto or similar for SQL capabilities on top of Hadoop.

Free software adoption: a technological change, an organizational challenge, a huge social opportunity

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Abstract. The introduction of a new technology within an organization can have an impact both on cultural values and on individual roles, requiring a greater effort in terms of change management. Studies on business organization and information systems have long investigated these kind of relationships. It is particularly interesting to analyze these aspects in the Public Administration, since the preference for the adoption of free software solutions has been defined for some years at the regulatory level. From an organizational point of view, free software migration projects require a strong sponsorship from top management and great collaboration between actors involved at the different levels. Moreover, the adoption of free software solutions is only possible if adequately supported and accompanied in a highly organized and participated process. The purpose of this paper is to demonstrate, also through the analysis of some practical cases, the prevailing organizational and social value of free software migration projects on purely technological aspects.

Keywords: free software, change management, organizational change, migration project, Public Administration, project management, Prince2.

1 Introduction

Change, in all its possible forms (strategic, technological, organizational, cultural), affects both material and immaterial aspects, referring to intellectual, relational and organizational capital of an organization [1]. It is possible to perceive it as a process that can also come to contradict choices that previously were successful, giving birth to the so-called organizational inertia, due to the resistance to the same change. This high-

lights the need for managers capable to take a leading role in the change process, sensitizing and forming the various levels of the organization and enhancing the support of Information Technology (IT) opportunities [2].

The nature of barriers within the organization towards change can be [3]:

- *individual*, in terms of lack of trust towards the proponents of change, uncertainty aversion, fear of seeing the organizational status reduced, poor understanding of the motivations related to the change itself;
- *social*, in relation to the possible presence of groups of people that have no interest in initiating change processes, and demonstrate little inclination to communicate with other organizational units;
- *organizational*, linked to the characteristics of the decision-making system, of the organizational structure, of the human resources management modalities, of the information system, that may hinder the progress of a change project.

Interventions to overcome these barriers can be activate to make goals and expected results more visible and shared, to promote training and communication actions, aimed at encouraging greater participation and enhancing personnel with respect to the paths of change, to develop better levels of horizontal coordination both internally and externally to the organization [4].

In the context of technological innovation projects, free software migrations are undoubtedly an interesting case to analyze about the change management aspects previously considered. Free software is published under the terms of a free license, which grants its use, study, modification and redistribution [5]. The main differences compared to proprietary software, as the ability to freely customize the software and adapt it to specific business needs, ensuring greater interoperability at a social level, impose the activation of change processes that can also heavily influence the organization.

Considering a free software migration project, there are in fact at least three aspects to consider:

- the *human* one, represented by users placed in front of a change;
- the *organizational* one, referred to actual processes and organizational structure;
- the *technological* one, based on the overall architecture of information system.

Actually, the organizational and social impacts of free software are not treated by the academic literature, focused on purely technological aspects[1]. Moreover, the human factor is generally underestimated, so much that it can become the main cause of an unsuccessful migration.

Also for this reason, therefore, it is important to:

[1] Literature analysis has been realized on the abstract of contributions, in the years from 2014 to 2018, of these publications: European Journal of Information Systems, Information Systems Journal, Information Systems Research, Journal of AIS, Journal of MIS, MIS Quarterly (first 6 excellence journal and review according to the ranking of Association for Information Systems (AIS)). The same results has been produced by the analysis of the first 20 pages of Jstor Archive Collection and Google Scholar, related to the keywords «Free software organizational aspects», «Free software social aspects» and «Free software Project Management».

- realize a written, detailed and shared project, involving professionally qualified people with specific experience (whether internal resources, if present, or external);
- evaluate not only technology, but also people (human factor), work organization, and related processes involved (which instead could be useful and appropriate to review and improve).

The growing spread of free software migration projects in the Public Administration[2] goes hand in hand with the regulatory evolution that has characterized the last few years.

The preference for free or re-use solutions in the PA has been defined by the Digital Administration Code for several time. Recently, after public consultation, the "Guidelines for the acquisition and re-use of software for the PA" have been published and approved. A working group composed of AgID staff and Digital Transformation Team realized them, basing on art. 68 "Comparative analysis of solutions" and 69 "Re-use of open solutions and standards" of the Digital Administration Code (CAD) [6], and in compliance with art. 71 "Technical Rules". The main document goal is to replace circular no. 63/2013 "Guidelines for the comparative assessment required by art. 68 of Legislative Decree 7 March 2005, n. 82 Code of Digital Administration" [7], in order to facilitate the PA in the acquisition and reuse of software, according to the open source paradigm. A trend also supported by the Three-Year Plan for Information Technology in the PA drafted by AgID [8], for the provision of a source code repository useful both for the PA and the developers community working for the PA. Among the strategic goals of the plan "the sharing of guidelines and software components that allow to reduce the implementation costs of new digital products, allowing reuse and interoperability; the spread of the open source paradigm, facilitating the creation of a community of applications developers and software components for the PA".

In the light of previous considerations, this paper is aimed to:

- explain how change is to be dealt with in a free software migration project in the PA;
- analyze the organizational peculiarities of different project phases;
- demonstrate how free software adoption can promote exchange and cooperation also from a social point of view.

Contents are the result of an ongoing study about national and international PA experiences, and particularly they are based on the analysis of the following cases: LibreUmbria, LibreDifesa, and LibreMetroTO[3].

[2] From now on, the acronym PA will be use in place of Public Administration.

[3] The LibreMetroTO project is in a preliminary phase. Project Manager are also students of master in “Free Software Management – II Edition”, Piemonte Orientale University.

2 Change Management in free software migration projects in the PA

The migration from proprietary to free software implies an organizational change, as it is influenced not only by the quality of technical interventions, but also by psychological factors related to the change itself. Although the suites present largely identical functionalities, users find it difficult to understand the change reasons, because it has an impact on entrenched customs which often have become automatisms.
For these reasons, the change process must be managed in a gradual and structured way through:

- a careful analysis of the previous situation;
- a detailed planning of the necessary steps, in order to ensure transparency for users;
- an effective communication of motivations and goals;
- a description of expected results from users, which are the central figures of the process.

2.1 The context analysis

According to national and international experiences of free software migration, the context analysis for the realization of the project must provide a study of the reference organizational environment, with a particular focus on specific roles.
In particular, the main features for a PA are:

- *Top Management*, decision-makers and structure managers both inwards and outwards;
- *Ict Management*, which respond directly to Top Management and can have relations with outsiders as a specialist;
- *Sector Executives*, which respond to Ict Management on specific aspects entrusted to them;
- *Sector Technicians*, that manage a specific sector and have the Sector Executive as a reference;
- *End Users*, that use tools the PA provides for the production of internal or external output to the organization.

All described actors must be involved in the migration project; defining a change without consider the needs of people at different organizational levels, leads to not respecting the planned path and, therefore, to failing. The support of Top Management is essential for starting up of the project; but also without having the determination of Ict Management, even with the conviction of Top Management, it will be possible to find elements leading to a deadlock. Sector Executives can create resistance, but often do not appear to be decisive. While Sector Technicians can be replaced by external resources, but then they are fundamental in the post project management and, if not involved, can make the project go back. Finally, End Users must be involved and supported, otherwise they may not be able to take off the project.

A structured and systemic approach requires to highlight, for the identified roles, specific motivations for which every organizational actor can be favorable or contrary to the project realization. At this aim, it could be useful to create a matrix, in order to deduce the different expectations, as noted by the experiences taken into consideration.

Table 1. Organizational actors and free software migration projects.

	Favorable	**Contrary**
Top Management	• Organizational improvements • Return to public opinion • Law compliance • Economic savings	• Opposition from the Ict management • Poor public opinion emphasis • Increase in operating costs
Ict Management	• Conviction of the project's goodness • Sector visibility • Sharing and support of other Sector Managers • Sharing with Sector Executives/Technicians • Non-degradation of the services of competence quality degree • Economic savings in favor of other sector projects	• No conviction about the project • Deterioration of the services of competence quality degree • Opposition or non-sharing from other Sector Managers • Economic savings not adequate to the necessary organizational effort
Sector Executives	• Conviction about the project • Specific project preparation • Identification of the critical elements of the project • Identification of the solutions for the critical aspects of the project	• No conviction about the project • No specific project preparation • No identification of the critical elements of the project • No identification of the solutions for the critical aspects of the project
Sector Technicians	• Conviction about the project • Specific preparation • Awareness of one's own role	• No conviction about the project • No specific preparation • No awareness of one's own role
End Users	• Information about the project • Awareness • Training • Technical support	• No information about the project • No awareness • No training • No technical support

Notice how, both for the most strategic and for the operational roles, organizational and personal motivations prevail over the technical ones. This confirms the change can firstly find legitimacy in an organizational context characterized by proactivity and sharing of intent.

2.2 The Project Management methodology

Free software migration projects require to define a progressive, planned and assisted path. The opportunity to reuse the good practices gained in other national and international analogous contexts allows to take advantage of the experiences to be located in the specific context.

The communication plan. Besides the technical analysis on existing software, it is important to plan an adequate communication campaign, to be carried out both internally to the involved public entities and through the press, in order to understand the reasons why free software will be adopted. Internal communication makes it possible to know the implementation methods of the project, to guarantee transparency in the activities and thus to break down one of the biggest limitations of innovative projects, the resistance to change.

The communication plan aims so to define the timing and the necessary actions to explain to users motivations and goals of the migration project. It is essential to highlight the opportunities to use a genuinely standard and open format and to contribute to the growth of software that benefits the entire user community (even at a global level). For this reason, users must be informed and aware of both the benefits and the problems they will have to face, in advance of the start of the migration process. The communication process needs to take place in close coordination with the Top Management, to guarantee the effectiveness of messages.

The training plan. Another important activity, preliminary to the free software installation, is the realization of survey about the training needs of users involved in the migration process, in order to organize frontal courses and e-learning. It is essential to set up a group of trainers within the involved public entities; they must be appropriately prepared and certified, and can deliver courses as well as provide support to colleagues in post-migration period.

The plan defines the training activity for users, and is aimed to illustrate the main features and functionalities of free software and the areas in which it is different from proprietary software (with particular attention to differences not so much in the functionalities - which are very similar - as in the menu position).

At this aim, it is important to:

- identify the delivery methods of the courses;
- define the courses' contents for the different user profiles;
- make the calendar of training activities.

The plan must also provide general training on the various modules functionalities and on a correct behavior in setting up new documents. In many cases, this will be perceived as a reward and will motivate the user very much, making it feel part of a big project. In this sense, spreading the importance of open formats is fundamental.

Moreover, it is necessary to train a selected group of users (in general, IT referents of the involved public entities) that become an important first point of reference for colleagues in the use of free software. End users can receive a survival kit containing

references, material, telephone numbers, e-mails, and all the necessary items to avoid difficulties in the daily office work.

Previous considerations allow to understand how free software migrations require approaches oriented to use a specific methodology for Project Management. Both national and international experiences show that the standard Prince2 [9] is mainly adopted[4].

By comparing the seven principles on which the methodology is based with the peculiarities of free software migration projects, the following aspects emerge:

1. *Continuous justification*: for a migration project the business justification can derive from the need to invest in different ways useful resources for the acquisition of software, but it can also the advantage of being disengaged from the seller and the program by choosing an open standard format. The justification can also change during the course of the project, but must be constantly checked: if and when it should fail, in fact, the project would no longer have reason to continue. The document within which it is formally described and approved is the business case, which is subject to formal control of the changes.
2. *Learning from experience*: in migration projects, thanks to the collection of materials that is usually realized and made available under a copyleft license, this principle is an important opportunity for all the PA that approach this kind of change for the first time. The process of writing and peer review, typical of creative commons licenses, allows the continuous improvement of experiences.
3. *Clearly defined roles and responsibilities*: in migrations projects, it is often thought that the information system of the public entity can take care of everything, without a precise reference figure, and defined roles and responsibilities. A mistake that inevitably leads to failure because in a complex project, having people with roles and responsibilities means creating a temporary organization, useful for the goals achievement.
4. *Management by phases*: in Prince2 the project is divided in phases so as to be able to manage it step by step, since the end of a phase is the ideal moment to make a formal check on the activity carried out and on that to be performed later. In free software migrations, this approach allows to constantly evaluate the feasibility of the project and carry out an advancement check at predefined times.
5. *Management by exception*: in migration projects, the Project Manager has a certain degree of flexibility and involves Executive and other members only when an exception occurs. Limiting the meetings and having the possibility to carry out independently the different activities is very important, especially in the Public Administration where human resources are often undersized.
6. *Focus on products*: in migration projects, as well as in many other types of projects, it is essential to try to break down the work always first for deliverables and then for activities. In this way, both planning and progress control will be facilitated.
7. *Adaptation to the project environment*: even the best good migration practices can never be replicated without being adapted to the organizational context. Customizing

[4] The PRojects IN Controlled Environments (Prince2) is the standard of Project Management with the British Government.

the methodology means ensuring that this is aligned with the organizational processes and that applied controls are coherent with the project environment.

2.3 Organizational aspects of the project phases

A free software migration project should favor a change in the habits of involved people, starting from a first identified core of pilot areas.

Users must be segmented for technical skills, training needs, and organizational units. These segments will form the basis for the planning of training and of the migration itself, so that the transition can take place for homogeneous groups. Within this path, the role of Technology Leaders is fundamental; they are people recognized for their technical competence and have, by culture or personal attitude, qualities of leadership, charisma, and communication. The Technology Leaders must be involved in the process from the early stages, based on a training course aimed to transform them into "migration evangelists", to support the change towards their colleagues.

The adoption protocol must be developed according to a Work Break-Down Structure (WBS)[5] approach, as recommended by Prince2, and using free tool for Project Management (e.g ProjectLibre) and for Project Monitoring (e.g. OPPM - One-Page Project Manager).

Generally, the project can be articulated into the following phases, or Work Packages (WP):

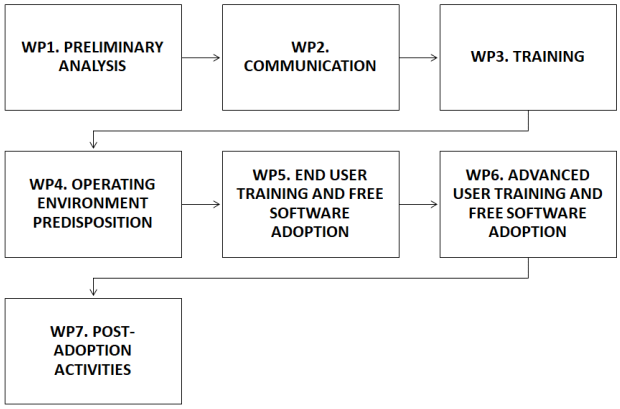

Fig. 1. Free software migration projects plan.

Basing on the analysis of some national and international PA experiences, each phase is characterized by specific organizational aspects, mainly related to the assessment of critical issues and actions taken to prevent or resolve them. They can be described as follows.

[5] A work breakdown structure (WBS) is a key project deliverable that organizes the team's work into manageable sections. The WBS visually defines the scope into manageable chunks that a project team can understand, as each level provides further definition and detail.

Preliminary Analysis (WP1). The organizational impact of this phase is found in the need to identify the methods for free software adoption, according to the characteristics and type of users work (also by questionnaire). It is also essential to identify the organizational impact of the technological change and decide the best ways to manage it. The identification of IT referents can support the change process, also from a motivational point of view. Criticalities can reside in: a not effective preliminary communication campaign for managers, administrators and end users; a lack of cooperation from users involved in completing the questionnaire and from the information system staff.

Communication (WP2). The organizational aspects of this phase is found in the need to communicate the benefits of the project to all involved actors and to make known in progress developments and repercussions, also from a social point of view. It is important to prepare the informative material (brochures, informative emails, posters), useful for communicating and disseminating the goals to all the users, and to publish on the Intranet of all involved public entities informative banners and news. Criticalities can reside in: an incorrect identification of a shared message to be disseminated during the communication phase; a poor management involvement; an inefficient use of press releases, brochures, flyers and newsletters.

Training (WP3). The organizational value of this phase is found in the creation and monitoring of courses for trainers, technical assistance staff and IT referents (which can be re-proposed after migration, basing on the identified needs, in order to increase the number of people to be allocated to user training and post-adoption assistance activities). Criticalities can come from: a not completed communication activity to trainers and technical assistance staff; an ineffective re-elaboration of data collected through questionnaires in the preliminary analysis; a poor sharing with managers of the involved public entities about the training activity methods and timing. Moreover, it is essential that the preliminary training involve all users operating in the organizational units that are subject of the free software adoption, through the use of educational programs, questionnaires for the detection of perceived quality, statistical reports on the training quality.

Operating environment predisposition (WP4). This is the most technical phase, based on software installation activities. The main organizational problems can arise from: an ineffective communication campaign to the users involved; a delay in starting up their training activities; the lack of training of specialized figures in technical assistance and installation; an incorrect drafting of the analysis documents.

End user training and free software adoption (WP5). The activities of this phase are aimed at organizing and monitoring the progress of courses for end users, preparing e-learning training courses to answer the users frequent asked questions and provide guidance on how to assist. The main problems may arise from: an incomplete training activity for trainers, technical assistance staff and IT representatives; a lack of sharing

with managers of the involved public entities about training procedures and performance (tutor, educational material, calendars, evaluation of the course and perception of the training quality, provided in itinere and ex post). The training activity must involve all users operating in the organizational units that are the object of the free software adoption.

Advanced user training and free software adoption (WP6). The organizational purpose of this phase is found in the implementation and monitoring of courses for new IT referents, basing on the needs and problems encountered during the project. It therefore requires new preliminary communication activities for IT users who will take advantage of the training activities.

Post-adoption activities (WP7). The organizational aspects of this phase are found in the need to plan the referents activities for telephone help-desk, to monitor free software adoption by evaluating specific indicators, to create a document with the best practices of project, to take care of the communication about the project outcome. The main critical issues may derive from: a lack of involvement of IT referents; the establishment of inadequate relationships between representatives, IT advanced users, communities of practice; an ineffective disclosure of the project results.

3 Focus on practical cases and lesson learned

Considerations set out in the previous paragraphs are fully reflected in some national cases of excellence, as described in the following sections.

LibreUmbria [10]. It is the project for the migration to LibreOffice of the major Public Administrations of Umbria: the Umbria Region, the Province of Perugia, the Province of Terni, the ASL 2. Following the foundation of the Open Source Competence Center (CCOS), for a conscious use of free IT tools and the dissemination of data representation open standards and formats, the project has started with the Province of Perugia, which presented a well-defined IT organization and an enlightened leadership. In December 2016, there were 1,200 migrated users, belonging to six different areas and, from November 2016, training courses on Impress and Advanced Calc had been activated to over 300 employees. Considering both internal and external costs, the migration to LibreOffice of 1,000 workstations has allowed a saving of about € 227,000. Together with the project plan, all the annexes have been published on the website, including the more technical ones, to which the plan refers. The goal of making available under “Creative Commons” license is still to encourage the reuse not only to other PA, but also to all those subjects who intend to deal with free software migration in a calm, reasoned way and without major criticism.

LibreDifesa. Basing on the LibreUmbria best practices, the project aimed at installing on workstations, as an alternative to the MS Office individual productivity software, the free LibreOffice software. The implementation process also envisaged the gradual adoption of the Open Document Format (ODF) for all documents, to guarantee the legibility over time and the security in the exchange processes. The project has been coordinated by the VI Department of Stato Maggiore della Difesa (SMD), using a joint working group between Forze Armate and Segredifesa. Training and impact analysis activities between LibreOffice and existing applications has been followed by the Support Information Systems Office of the VI Department of SMD. A collaboration agreement with the Associazione LibreItalia onlus has made it possible to have the necessary documentation to evaluate the security of the suite, to find a solution for the implementation of LibreOffice within the document systems, to host informational seminars on the advantages of the transition to LibreOffice both at the management level and the technical one, to take advantage of free training courses for trainers and installers, to dispose of educational material for the implementation of e-learning courses on LibreOffice. The training course for trainers has allowed to set up teams of experts on the use of LibreOffice, able to support users of the involved entities in the migration process. The course for installers was designed to illustrate how to customize the LibreOffice package, in order to find coherence with organizational processes. By 2020 it is estimated that 100,000 workstations will be migrated, with an expected saving of € 29M.

LibreMetroTO. Basing on the LibreUmbria and LibreDifesa best practices, the project intends to define the phases and operational procedures for the migration from MS Office to LibreOffice of about 800 workstations used by the staff of Città Metropolitana di Torino, also trying to perfect the existing management systems, making useless spreadsheets and databases installed locally by users.

A comparison between the described cases makes it possible to highlight some salient and extremely important points about the change processes related to free software adoption:

- *Compliance with the standard, ethics and savings*. The purchase of proprietary software licenses entails a considerable and unsustainable investment, as well as being difficult to justify, given the availability of free software, which can completely satisfy the needs of office automation. In line with the relevant regulations, savings implemented with the collaboration of all make it possible to reinvest resources in other activities, such as the processes modernization and reengineering, allowing the current quality standards to be maintained even when resources are reduced. It is important to underline the fact that, especially in the PA, proprietary software is largely underutilized: the preliminary analysis of LibreDifesa and LibreMetroTo projects, carried out as a sample on the use of the Office programs, has shown that 94% of users use Word, 87% Excel, 33% Powerpoint, 12% Access.

- *Continuous social improvement*. Thanks to sharing useful guidelines, every new project can take advantage of established practices and improve them through a contextualization of procedures and tools in the specific organizational context. Naturally, it is appropriate to carry out an adequate preliminary risk assessment through the drafting of a monitoring plan. Risks can be related to the complexity of the project (e.g. strategic relevance, actors heterogeneity, interconnection with other projects) or to the uncertainty degree (participation, directional support, processes formalization).
- *Change and monitoring activities*. Being change projects with a strong social value, the results and impacts of free software migrations should be monitored over time through appropriate systems of indicators. The described projects have been used three kind of indicators: I) Status indicators, to measure the progress of the project both in terms of expenditure and goals achieving, and to assess the internal efficiency of interventions; II) Dynamic indicators are detected at 6-12 months from the end of the experimental exercise period, to analyze the variation in time of the level of use of project products and to evaluate the project effectiveness; III) Socio-economic well-being indicators (BES) indicate the state of correlated variables with the socio-economic well-being of the public entity that refer to technological and organizational change.

Furthermore, an evaluation system is only valued if it is supported by organizational processes that are sensitive to the culture of quality and continuous improvement.

In conclusion, it can be said that collaboration is the key to the success of a large-scale project such as the free software adoption, which wants to bring innovation but, above all, aspire to demonstrate how migration is possible as long as it is adequately supported and accompanied, in a participatory process that leads to simplification, saving and greater quality in the produced work.

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Do-it-Yourself with digital: a women's world?

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Abstract. The purpose of the research is to contribute to the debate about DiDIY (Digital Do-It-Yourself), the phenomenon of the diffusion of DIY practices thanks to the use of digital technologies. Based on a sample of 591women, mainly employed in public administrations, the study analyses women approach to digital technologies and DiDIY. It acknowledges the existence of female DiDIY workers and sheds light on their personal characteristics and on the organizational context that foster their DiDIY activities. The profile of the female DiDIY worker emerging is the one of individuals digitally literate and highly aware of their skills, who define themselves as curious and eager to innovate. They declare to have developed their digital skills mainly on the field and/or they are self-taught. They pursue DiDIY mainly for professional purposes, qualify themselves as expert amateur and are proud and conscious of their potential contribution to the improvement of their lives and their workplace. With regards to the organizational context, female DiDIY workers are concentrated in those functions that link the company to the external environment (Marketing, Customer Care, Research & Development).

Keywords: DiDIY, Makers, Female DiDIYer's Profile, DiDIY Worker.

1 Introduction

In today's organizations workers that autonomously shape their activity with the help of digital technology contribute to innovation and adaptation, which in turn allow stability and growth. A recent project entitled DiDIY (Digital Do-It-Yourself) funded by the European Commission studied these characteristics and synthesized them introducing the term DiDIY worker, or DiDIYer. Digital Do-It-Yourself (DiDIY) [1] is a complex, manifold and dynamic phenomenon enabled by the increasing accessibility and ease of use of digital technology and its deriving ubiquity in every aspect of the life of people and organizations. As such, DiDIY is claimed to have the potential to provide organizations with a leverage for competitive advantage based on technology bud aimed at enhancing individuals instead of substituting workers with machines.

Neither the stream of research devoted to firm's digital transformation, nor the one dedicated to the new concept of market orientation – the so-called *customer centricity* [2] - consider explicitly this phenomenon. Nevertheless, the study of the evolution of firms and organizations needs to consider new paradigms where the role of individu-

als dealing with digital technologies with creativity and a multidisciplinary approach gives birth to new unforeseen pictures [3]. The DiDIY phenomenon helps getting a more complete view of the forces that will drive change in the organizations in the near future, but at the same time its novelty implies the need of a deeper investigation in many directions.

Within this rapidly changing environment, the study here presented has the purpose to explore one of these directions: the relationship between gender and technology. This topic has been for decades the subject of a stream of research. We acknowledge the results of the existing scientific literature, yet we argue that the revolutionary characteristics of the so-called "digital world", implying the need of new competences, might disrupt the stereotype of the marginal role of female workers in technology-rich environments [12]. This shift, if demonstrated, might lead female workers to stand at the center of the digital transformation processes: our study seeks to explore what is the role of women in such a digital world. Following the path of recent research aimed at defining the organizational implications of DiDIY, we focused on the characteristics of the female DiDIY workers. Through a survey we outlined women's approach to digital technologies and how they enact DIY by using such technologies [3].

2 The DiDIY phenomenon

DiDIY is an acronym introduced in a EU project funded under the H2020 framework, to acknowledge a set of streams of transformations undergoing within the society, and in particular within work and organizations [4]. It is the evolution of the widely studied DIY phenomenon: the ubiquity of digital technologies, their accessibility and ease of use are enabling individuals to enact DIY behaviors in the workplace, often leveraging on the knowledge sharing in communities of peers, thus leading to disintermediate the roles of experts. When such behavior occurs, such individuals can be called "DiDIY workers", characterized by a "DiDIY mindset".

DiDIY acknowledges the autonomy and the empowerment that characterizes individuals in the digital era. It concerns not just the mastery of technological competencies which is facilitated by the usability of smart-devices, but a novel relation between technology and people. In the workplace, this leads to continuous, self-promoted innovation 'on the job' [5, 6, 7].

Under the definition of DiDIY it is possible to place the so-called *Makers*: individuals aiming at creating, modifying or maintaining objects exploiting the potential of digital technologies [3]. When this term was introduced, Makers were mainly startuppers dedicated to manufacturing activities, so they had often been addressed also as "digital artisan", expected to transform the industrial production's process into a desktop accessory. More recent research about Makers pointed out the presence of similar individuals active within different workplaces and within the services industry, such as hospitals and retail companies [3]. Thus, Makers can be seen as a subset of the more general set of DiDIY workers (or DiDIYers), characterized by similar attitude and competences, independently on the economic sector they operate in [11].

A work by Guerini and Minelli [10] acknowledges the most important antecedents of DiDIY in digital literacy. DiDIYers' drivers and approach can be related to an internal force (curiosity, intention to take on a challenge, a desire to experiment creatively) or to a momentary thrill. The profile of DiDIYers thus depicts passionate people, motivated by internal stimuli, that are not interested in measuring the benefits of their actions in terms of effectiveness and efficiency, but highly oriented by a community vision [10]. DiDIYers can thus be described as enthusiastic people, creators and artists that play with technology, driven by the aim of sharing and favoring participation [10].

2.1 Gendered DiDIY

The joint consideration of gender and technology is at the heart of this research project. Technology has been always associated to men since its diffusion after World War II [12]. In particular, within the IT (information technology) industry, women who try to escape glass ceiling phenomena through self-employment and entrepreneurship, face hindrances in the access to technological and social capital [12]. Women's massive consumption of social media is well known, yet the use of social networks per se do not transform every user into an active *producer*. Indeed, gender imbalance in technical expertise turns out to be an important obstacle to full inclusion into the digital society and to enjoy the opportunities it opens up[13]. Thus the potential for empowerment offered by IT can be realized through the advancement of women's technical skills. Recent studies focus on how technologies are associated with the crystallization of social relations of different kinds [12, p. 950] giving rise to "the particular knowledge/power relations that establish the hegemonic norms of gender … and technology in particular contexts" [14, p. 216]. Organizational relationships are affected as well by gender imbalance in technical skills.

The environment of the so-called "4th industrial revolution" is quickly reshaping individual skills and abilities, besides business models. In this context, the analysis of female Makers, their aptitudes and projects were profiled in a survey made by Intel Corporation [17]. The purpose of the survey - launched in three countries, namely China, the U.S., and Mexico - was expressly to investigate the engagement of women in maker mindset and, if there, the space to increase it. Feminine makers are keener than men on self-describing in artistic and creative terms. Art and creativity also depicts their interest and approach to making. The use of computer or technological means are, in that sense, only tools and useful way to sort out projects. In the survey most of the respondents recognize to be deeply attracted by the social principle of solving problems with their activities. A higher number of women than men stated that a fundamental tool to carry out their project are inter-relationship. Creating networks emerged as well as an important benefit to them. More generally, they consider the possibility to weave in Makerspaces the means of enhancing growth, capabilities and innovative mindset and a place, in which they find more gender acceptance and empowerment. Even if the study acknowledges the importance of female Makers, thus contributing to the depiction of a gendered profile, it underlines also lots of barriers that still exist in female Making.

2.2 Organizational culture and DIDIY

DiDIY is fostered by the organizational culture in which people operate, considered one of the most important "environmental conditions"[18, 19] for the development of the phenomenon within enterprises and professional environments. Organizational culture consists of basic assumptions, approaches and patterns of action shared among the organization's members that can enable or inhibit DiDIY.

In that sense, a participative culture [20] constitutes the humus in which DiDIY can put down its roots. Over the last decades, business organizations have developed their activity in increasingly competitive environments [21], in which customers' changing demand and rapid technical changes create greater uncertainty than in the past [22]. In this scenario, the adaptability of companies in environments increasingly marked by change is key. It becomes urgent to give great importance to the development and the exploitation of intangible assets of organizations, such as individual knowledge or skills, as they facilitate differentiation and hinder imitation by competitors and favor success.

Organizational culture plays a very important role in innovation and, consequently, in obtaining lasting competitive advantages over time too, since it stimulates, or tries to stimulate, innovative behaviors in the members of the company, to the extent that the members accept and embrace innovation as a key value in the organization and commit to it [23]. The elements that make up the culture have an influence on individual innovativeness through socialization and coordination [24, 25]. Through the first one, members acquire knowledge on what creative behaviors the company pursues. Thanks to coordination a series of activities, policies and procedures - through which the company aims to promote a set of principles and values - foster innovative capacity [24]. The stream of literature about open innovation highlights how organizational and social aspects are connected with the firm's innovative performance, underlining the role of change agent, as well as that of cross-functional interfaces and systems for managing collaborations [26].

Though recent evolutions of the DiDIY stream of research extend their contributions to the analysis of DiDIY workers, there are not, so far, studies devoted expressly to the organizational aspects that impact on the emergence of DiDIYers or to the relative diffusion within the organization. These aspects are particularly relevant to the study of the rise of DiDIY among female workers, since they may bring about the conditions for women's technological empowerment in the digital society.

2.3 The research questions

On the basis of the operational definition of the DiDIY project [11] – which pinpoints the DiDIYer as an individual or an aggregate of individuals, who carry out "on their own" certain activities by means of digital technologies and exploiting the knowledge sharing within a certain community- a research was designed to identify female DiDIYers and to investigate their personal characteristics, in particular their digital skills, and the organizational conditions that they experience. In details, the study aims at analysing the female approach to digital technologies and DiDIY as well as the fea-

tures of women DiDIYers, and in particular their demographic and professional traits, the organizational drivers that foster their activity, their goals and mindsets.

More precisely, the research questions are:

- What are the personal characteristics of female DiDIYers?
- What are the organizational conditions that foster the DiDIY phenomenon in this female sample?

3 Sample, methodology and research tools

The study involved a sample of women working in the Municipality of Milan (and its agencies), in a small University located in North Italy and some members of a well-known female membership corporation (Valore D). The on-line survey allowed the collection of a large amount of data overcoming time and distance problems. The questionnaire developed for the purpose was organised in five sections concerning personal references, professional experience, digital literacy, attitudes towards digital technologies and approach to DiDIY. Women were invited to participate in the survey by e-mail. Data collection took place from April to July 2017, and a large amount of responses was obtained. On the whole, the survey gathered 591complete questionnaires; 492 filled in by women working in the public sector (Municipality of Milan). Even if the sample is based on convenience and is not statistically representative, it provides a meaningful picture of women's skills, attitudes and expectations towards digital technologies and DiDIY within the Municipality of Milan. The results of the survey were analysed through quantitative methods. Responses were statistically treated in different ways, according to their nature (i.e. numbers, categorical variables and ordinal variables) [27, p. 310].The quantitative approach was suitable and appropriate to the study for the richness of the information obtained, allowing researchers to gain further insights into the research problems [30].

4 Results and preliminary discussion

4.1 Women' s approach towards digital technology

The 591 sample components - 83% of whom working in the public sector – are on average 49 years old, ranging from 25 to 64. The great majority (69%) was born in Lombardy. Their education level is highly differentiated (44%university degree, 37% technical diploma, 12% high school diploma). Besides, some of them (14%) declare to participate actively in some associations. Their job roles are diversified, both the function and the hierarchical level. 58% are employed in administrative roles, 16% in Human Resource Management and 13% in Operations. Most of the sample (69%) work in a large organization (with more than 250 employees and 50 million Euros turnover), which implies that they are familiar with complex work processes and relationships. Moreover, women comprised in the sample generally work in team (78%) and many of them refer to a community of practice (35%) in their jobs.

Notwithstanding the complexity of the work environment, their job context is mainly characterised by informal coordination mechanisms. In particular informal communication prevails (84%), followed by the definition of the objectives to be achieved (42%), meetings (26%), definition of process standards (24%), mutual adjustment (24%), rules and procedures (18%) and other systems. Informal communication overlaps to almost all other mechanisms.

On average the respondents rate their digital skills 2.8 (on a 1 to 5 scale where 1 means very low and 5 means very high), with 3 as median value. On the whole, they perceive themselves as moderately expert. Awareness of being a digitally literate person is a component of digital literacy [28], which implies the ability to use digital tools and facilities suitably to manage digital resources, build new knowledge, communicate appropriately to allow constructive social actions and reflect on this process. Most respondents acquired their digital skills through field experience (56%), 21% are self-taught and only 13% had formal training. This implies that they are mainly self-motivated in developing their digital skills.

Hobbies and gaming are the main fields of application of digital skills (18%), followed by professional use of social media to coordinate collaborators (8%) and marketing purposes (4%). The other respondents pinpoint other uses, not better specified. It is interesting to notice that not only women that apply their digital competences for professional purposes (use of social media in management, website building, development of applications), but also those who apply them for entertainment purposes reveal higher skills than average (3.2 out of 5). Thus, also in this female sample gamification plays an important function in motivating people to acquire digital skills [29].

Women were asked to describe their approach to digital technologies in their (personal and) professional life. The answers highlighted average values above 3 (out of 5) referred to every proposed item (assiduity, curiosity, awareness, trust, reliance, pleasure, innovativeness, familiarity, adjustment, and passion) with the exception of "fear" and "constraint". In more details, assiduity and curiosity score 3.5 (out of 5), while awareness, trust and reliance score 3.4. In order to understand the women's attitudes, a factor analysis was carried out that revealed a two-component solution[1]. The components represent opposite attitudes towards digital technologies, namely a positive and a negative one (Table1).

Table 1. Rotated component matrix of attitudes towards digital technologies.

	Component	
	positive	negative
Pleasure	0.872	
Passion	0.866	
Curiosity	0.835	
Assiduity	0.78	
Innovativeness	0.769	
Familiarity	0.768	
Awareness	0.752	
Trust	o.739	
Reliance	0.648	

[1]60% total variance explained. Varimax rotation

Constraint		0.751
Fear		0.699
Adjustment		0.676
Cronbach's α	*0.921*	*0.530*

Then a regression analysis was carried out to investigate the conditions that influence women's approach to digital technologies. The dependent variables were the scores in the two attitudes (positive and negative), and the predicting variables included the age of the respondents, their perceived level of digital skills and the size of the organization they work in, as an indicator of organizational complexity. The results of the regression analysis show that the perceived level of digital skills is a predictor of a positive attitude, whereas employee's age and organizational complexity appear to be not significant (Table 2).

Table 2. Regression coefficients for the positive attitude towards digital technologies.

	Coefficients[a]				
Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	2.196	0.307		7.144	0.000
age	-0.007	0.004	-0.071	-1.68	0.094
To what extent do you consider yourself an expert?	0.497	0.036	0.556	13.89	0.000
What is the size of your organization?	0.035	0.087	0.017	0.402	0.688

a. Dependent Variable: positive attitude

Following the results, organizations can pave the way for digital transformation through employees' digital skill reinforcement, almost regardless of the average age of staff. This is quite important, considering the need of organizations - and of public administrations too - to successfully manage digital change and the ageing of workforce. Moreover, the fear of making mistakes does not hinder the search for innovative solutions through digital technology: the perception of fear seems to boost innovativeness along with curiosity signaling that digital experimentation cannot be without fear of making mistakes but it is supported by digital skills.

In any case, both in work and in social life, vis-à-vis (traditional) relationships are preferred to computer-mediated relationships (Table3). Human contact still remains a key component of effective workplace relationships, though it is far less important than in social life[10].

Table 3. Type of relationships preferred by women.

Context	Type of relationships		St.dev.
	vis-à-vis	digital technologies	
Work	55.5%	44.5%	19.9
social life	71.1%	28.9%	18.5

4.2 Women's attitude towards DIDIY

Women in the sample were also asked to indicate their level of agreement (on a scale 1 to 4) to given do-it-yourself (DIY) perceptions. DIY is considered mainly "a satisfaction" (3.7 out of 4), "able to develop skills and favour independence" (3.3 out of 4). There is *vice versa* a low level of agreement on negative statements defining DIY as "stuff for nerds", "boring" or a "waste of time" (<1.6). The factor analysis carried out on the results revealed a two-component solution[2]. The two components are respectively usefulness and personal and professional development (Table 4).

Table 4. Rotated component matrix of DIY perceptions.

DIY	Component	
	usefulness	development
permits money savings	0.757	
reduces waste	0.745	
is useful to find a job	0.633	
combines technology and art	0.554	
is a hobby	0.535	
is reassuring	0.478	
is a satisfaction		0.762
develops skills		0.727
fosters autonomy		0.691
favours one's aspirations accomplishment		0.551
Cronbach's α	*0.759*	*0.683*

This result highlights that women perceive DIY as a useful practice that is capable of fostering the accomplishment of their personal aspirations and the acquisition of professional skills.
Asked to express their level of agreement to some propositions concerning the Digital-Do-It-Yourself phenomenon, they agree to consider it a 'fundamental work tool', not only for their jobs but also for the world ("good ideas will save the world"). Besides, all the statements that depreciate the DiDIY phenomenon are rated lower than those supporting it, demonstrating that there is possibly a negative side of DiDIY that does not overshadow the positive aspects.

4.3 The female DiDIYers' profile

Among the respondents of this survey, a group of 38 women stands out: they are DiDIYers and Makers in 32 cases. These female DiDIYers are at the core of this study and confirm that there is a female approach to digital technology and DiDIY.

Slightly younger than the whole sample (48 years old) - even if much older than the sample of Intel Corporation's survey [17] - most of the Italian DiDIYers were born in Lombardy (58%) and as many as 60% have a degree or a higher education level. The large majority (71%) are employed in the Municipality of Milan, use to work in team (82%) and quite frequently refer to a community of practice in their

[2] 50% total variance explained. Varimax rotation.

professional activity (39%). This result confirms that DiDIY workers possibly exploit the knowledge sharing within a certain community of individuals, or of organizational entities. This aspect deals with the innovative notion of Do-It-Together, where "together" refers to a community the DiDIYer belongs to [3].

Female DiDIYers perceive themselves as experts (3.6 out of 5). Comparing them with the whole sample, a higher percentage of DiDIYers had specific training in digital skills (21%), whereas 42% acquired her skills thanks to field experience or are self-taught (18%). In line with the whole sample, most of them (60%) are self-motivated in developing their digital skills, even at a higher level of skill. DiDIYer's main purpose of digital skills application is professional use (39%) rated higher than for the whole sample, followed by apps development (26%) and website building (16%).

Almost half of the women who work in the Information Technology function are DiDIYers (46%), while 29% of the women working in Customer Service, 25% in Research & Development and 23% in Marketing (23%) maintain they are DiDIYers. Therefore, the areas where women DiDIYers are mostly present are those related to technology (Information Technology and Research & Development) and connected to the external environment (Customer Service and Marketing). A first interesting result regards the concentration of DiDIYers: DiDIYers are not uniformly present in all functions. This outcome suggests that some kinds of activities stimulate and require a DiDIY attitude, in particular those connecting the organization with its environment.

Depicting their approach to digital technologies in their work and personal lives, women DiDIYers evaluated awareness, curiosity and innovativeness higher than the other items and feelings proposed (respectively 4.2, 4.0 and 3.9 out of 5) and higher than the scores of the whole sample as well. This result shows that awareness is an important indicator of digital literacy and that - together with curiosity and innovativeness - it represents a driver of expertise and a motivator of digital improvement.

Moreover, passion and pleasure (respectively 3.7 and 3.6 out of 5) demonstrate that women DiDIYers are not only technology adopters but expert amateurs [7].

The factor analysis carried out revealed a two-component solution[3]. The components are represented in this case by the meanings that the digital technologies take on for female DiDIYers, namely innovation and reliability (Table 5). In details, in this type of analysis the components are not represented by the dichotomic perception (positive and negative) of the value of digital technologies, as for the whole sample, but by a deeper awareness of the impact of digital technologies on their lives.

Table 5. Rotated component matrix of women DiDIYers' attitudes towards digital technologies.

	Component	
	innovation	reliability
Innovativeness	0.863	
Curiosity	0.851	
Passion	0.825	
Pleasure	0.795	

[3]68% total variance explained. Varimax rotation

Familiarity	0.507	
Assiduity		0.881
Awareness		0.753
Adjustment		0.736
Reliance		0.600
Cronbach's α	*0.886*	*0.708*

Notwithstanding their digital skills, women DiDIYers' propensity to vis-à-vis relationships is similar to the whole sample (Table6), pointing out that the human touch is predominant in social life and cannot be replaced by virtual relations.

Table 6. Type of relationships preferred by women.

Context	Type of relationships		St.dev.
	vis-à-vis	digital technologies	
work	55.8%	44.2%	21.0
social life	69.0%	31.0%	20.5

In the case of the sole DiDIYers, the approach to DIY is coherently positive: they generally perceive it as a satisfactory opportunity (3.5 out of 4), that favours the development of new skills (3.3) and personal autonomy (3.2); they consider it a combination of technology and art (2.9) whereas negative statements about DIY are rated very low (<1.5). Most of them used software for the creation and management of websites and blogs or for the realization of digital videos; some also used 3D printers and scanners and a few made use of electronic prototyping cards (such as Arduino, RaspberryPi, etc.).

In general, female DiDIYers think that there is still a lot to do in the field of digital applications for professional use (89%), in particular for relational and technical purposes. In fact, 26% of them developed, and in some cases even realised applications devoted to the improvement of coordination and collaboration, for control purposes (26%), to improve efficiency (26%) and 11% to improve effectiveness.

In their digital activities they are not motivated just by curiosity or game: women DiDIYers are pushed also by innovation, personal intuition and experimentation (26%) and, above all, by professional challenges (60%). Therefore, in this sample women reveal that as their digital literacy grows, they are less motivated by ludic aims and increasingly by innovation purposes and professional challenges. Gamification can thus play an important role in approaching digital technologies and training basic digital skills but it seems to lose its appeal at a higher level of competence as a learning driver, when innovation, personal and professional challenges become increasingly important.

5 Conclusions

This study analyses the female approach towards digital technologies and DiDIY and shows that women in this sample are self-motivated and have mainly acquired their

digital skills through field experience or self-training. A regression analysis shows that the perceived level of digital skills is a predictor of a positive attitude towards digital technologies, whereas employee's age and organizational complexity appear to be not significant. More, the research results highlight that women perceive DIY as a useful practice that is capable of fostering the accomplishment of their personal aspirations and the acquisition of professional skills. The women of the sample mostly work in complex organizations, characterized by teamwork and direct communication as a system of coordination. Some of them refer to a community of practice in their job, underlying the importance of professional links, both within and outside the organization. As highlighted in the literature, managerial and organizational antecedents, among which systems for managing collaborations, are associated with innovative performance [26]. These evidences contribute to show that digital skills enhancement and organizational systems for managing collaborations can help the digital transformation in organizations, even within a context of workforce ageing.

The survey also allowed the detection of 38 female DiDIY workers within the sample. They are slightly younger, digitally more expert and more frequently engaged in formal technical training than the sample on the whole. The main purposes of DiDIY activities are the achievement of professional challenges, innovation objectives, personal intuitions and experimentation purposes, and not entertainment or gaming objectives. These results show on one side that self-motivation is the main driving force in developing digital skills also for DiDIYers; on the other that gamification appears to be important when women firstly approach digital technologies, whereas being DiDIYer entails the consideration of other levers, in particular personal and professional challenges and the appeal of innovation. As expected, the attitude towards digital technologies of female DiDIY workers is highly positive. Female DiDIYers describe their attitude towards them primarily with the concepts of awareness, curiosity and innovativeness, confirming that the awareness of being a digital expert is one of their fundamental traits. They do not show just a dichotomic perception (positive versus negative) of the importance of digital technologies, but a deeper understanding of it: awareness is to them a precondition to innovate and to rely on digital technologies in social and professional life. Besides, the cited "passion and pleasure" demonstrate that women DiDIYers are not only technology adopters but above all expert amateurs [7]. A further evidence is that female DiDIY workers are concentrated in a few organizational areas, and in particular in those functions that connect the organization to the external environment, such as Research & Development, Marketing and Customer Service. Direct and informal coordination, teamwork, participation in community of practice and connections with the external environment are the emerging characteristics of the female DiDIYers' workplace. Some roles appear thus more connected to DiDIY activities, suggesting that functional culture and/or the functional activities may foster DiDIY attitude.

Concluding, female DiDIY workers' personal characteristics seem to confirm previous studies dealing with the ungendered DiDIYer's profile [10]. Female DiDIYers are digitally literate and aware of their skills, curious and eager to innovate. At the same time, they are proud and conscious of their potential contribution to the improvement of their lives and their workplace. In their opinion the developing technology feeds on creative experimentation and becomes almost a vision of the world.

Differently from previous studies devoted to the analysis of gendered profiles [17], Italian female DiDIYers seem not confined to computer's desktops, citing experiences related also to IOT, 3D printing and so on.

These results are important to cast a light on the relationships between gender and technology. Since technologies are associated with "power relations that establish the hegemonic norms of gender" [14, p. 216], technological skills are key to the inclusion in the digital society and gender imbalance in technical expertise prevents women to build the potential for their empowerment. The issue of the enhancement of women's digital skills is even more important in the perspective of the spread of the so-called '4th industrial revolution' to achieve their full inclusion in digital society.

This study aims at advancing the knowledge of the DiDIY phenomenon in the gender domain. However, it has several limitations They include issues related to: (a) sampling, (b) participants' level of honesty and accuracy; (c) the study was also limited to one country (Italy) and (d) mainly public administrations. In particular, women from the private sectors may affect the results.

Nevertheless, the study helps shed some light on women's attitude towards digital technologies and DiDIY, acknowledging the existence of female DiDIY workers in complex organisations and depicting some peculiar features of women DiDIY workers. Further research in the female DiDIY domain is definitely to be encouraged due to the benefits ascribed to it by respondents and to investigate the conditions for a full women's inclusion in the digital world.

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New Business Models for Sustainable Urban Mobility Projects in Small and Medium-Sized European Cities

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Abstract. Bad air conditions, limitless traffic, overloaded parking spaces are just some of the modern mobility problems that strike cities on a daily basis.
The European Commission strives to address these issues by providing measures to improve the urban mobility situation in the small and medium-sized cities. The SUITS project (Supporting Urban Integrated Transport Systems: Transferable Tools for Authorities), which is financed under the umbrella of the HORIZON 2020 programme, aims at increasing the capacity of local authorities in Small and Medium (S-M) cities through the development and implementation of sustainable, integrated and accessible transport strategies and technologies.
This paper aims to introduce the innovative business models in urban mobility sector in order to increase the capacity building of S-M cities' transportation authorities to implement new mobility solutions. It describes the innovative mobility business identifying the most successful services and partnerships in the sector.

Keywords: Business Model Innovation; Small and Medium-Sized Cities; Mobility; Transportation; Digital Transformation; Sharing Economy; Horizon2020

1 Introduction

The capacity of developing or reshaping organisational business models requires organizational know-how and tools. Only well-developed business strategy enables the transportation and mobility organisations to receive the investments, and well-chosen partners may only reinforce the chance of success.

Bad air conditions, limitless traffic, overloaded parking spaces just some of the modern mobility problems that strikes cities on a daily basis [1].

A changing mobility paradigm that properly tackles today's challenges and accommodates current and emerging societal trends will clearly require research into new mobility scenarios, technological innovations, additional mobility services and solutions [2] as well as a new partnership schemes. Over 70 % of the EU population lives in the cities (including small and medium-sized cities) and account

approximately 85 % of the Union's GDP[1]. The present mobility situation has created unsustainable conditions for living: severe congestion, poor air quality, noise emissions as well as a high level of CO2 [3]. The increase of private vehicle brought to increased urban sprawl and commuting, however, the expansion of public transport networks has not reached the same development level [3].

European cities have common challenges that regard the enhancement of urban mobility, accessibility improvement, and creation of high quality and sustainable transport systems while reducing congestion, pollution and accidents.

Big European cities are well-known for their critical urban mobility situation, while S-M cities are left behind with respect to basic services and lack the necessary institutional capacity to manage their rapidly growing populations and as a consequence the mobility situation [4,5].

The European Commission has identified this problem and is searching to provide measures to solve the mobility issues in the S-M cities. For instance, SUITS project (Supporting Urban Integrated Transport Systems: Transferable Tools for Authorities)[2], financed under the umbrella of the HORIZON 2020 programme aims at increasing the capacity of local authorities in S-M cities to develop and implement sustainable, integrated and accessible transport strategies and technologies.

SUITS project targets local authorities and stakeholders in S-M cities who are in charge of the decision-making process for creating new mobility businesses or improvements of the existing ones, developing new partnerships or preparing the projects for the investment.

Following these objectives, this study aims to contribute to the scientific literature as well as to provide the examples of innovative business models and partnerships in urban mobility to increase the capacity building of S-M cities. The innovation of this paper contains in provision of examples of the modern mobility trends identifying the most successful mobility services and their business models in the mobility sector as well as innovative forms of partnerships identified during the research.

To this purpose, our research question emerged as follows:

- *RQ: What are the key characteristics of the innovative business models that allow improving the urban mobility situation in small and medium-sized European cities?*

[1]European commission. Urban Mobility Package - https://ec.eu- ropa.eu/transport/themes/urban/urban_mobility/ump_en

[2] https://ec.europa.eu/inea/en/horizon-2020/projects/H2020-Transport/Urban-Mobility/SUITS

In order to answer our research question, this study analyses innovative business models and partnerships that can be developed in the mobility sector of S-M cities in order to improve the urban services in these settings.

This paper presents the first investigation regarding new business models for sustainable urban mobility projects in S-M-sized European cities. The more profound studies in this area are foreseen in the future works.

2 Theoretical Background

2.1 Urban Mobility Trends

The current economic scenario shows that people entering the global middle class want to buy cars: automobile sales are predicted to increase from about 70 million a year in 2010 to 125 million by 2025, more than half are foreseen to be purchased in cities. Some automotive analysts predicted that today's 1.2 billion strong global car fleet could double by 2030 [6]. The existing urban infrastructure cannot support such amount of vehicles on the road. Congestion has already reached unbearable conditions and can cause such problems as time waste, wasted fuel, and increased cost of doing business[3].

Despite these worrying facts, the transport and mobility community is trying to find solutions to current situation. Different innovative approaches appear to solve transport problems. Many of them are due to the rapidly evolving technologies and digitalization [7]. The technological revolution has changed the way the mobility and transport sector operate. New business models emerged changing the way the transport organisations run their businesses revolutionizing the way of providing services, introducing new value propositions and types of partnerships.

An example of innovative way of improving the urban journeys is new "multimodal" services that facilitate everyday journeys combining walking, cars, buses, bikes, etc. [8] as well as shared transportation services and Mobility as a Service. These services not only enable to innovate the way travellers move but also help to solve the main mobility problems and the technological development plays an important role.

In addition, the European market of Intelligent Transport Systems (ITS) is growing fast. According to a Swedish study, the market value of ITS in public transport vehicles such as buses and trams is expected to rise from €1.03bn in 2014 to €1.46bn by 2019. Developing apps and digital platforms-based services for smartphones or other mobile devices is a fast emerging economic sector especially regarding urban mobility, at the base of the sharing-mobility models.

Table 1 provides the insight from the ongoing shifting paradigm in the urban mobility transportation from traditional way towards new solutions.

[3] https://www.mckinsey.com/business-functions/sustainability-and-resource-productivity/our-insights/urban-mobility-at-a-tipping-point

Table 1. Traditional mobility schemes vs new mobility trends

Traditional mobility strategy	New mobility solutions
Individual car ownership as a main form of transport.	Individual car ownership as one form of multi-modal, on-demand and shared transport.
Limited consumer choice and poor variety of services.	Bigger variety of services and service providers.
Government-funded public transit.	Public and private partnership.

New mobility services paradigm taken place also for individual-based mobility, changing the business models in the sector. The following shifts can be noticed: 1) from private car ownership to car sharing; 2) from taxi services to e-haling (process of ordering a taxi or car via on-demand application. App matches a client and a driver).

Concerning group-based mobility, it is also facing new tendencies: such as shift from public transit to on-demand private shuttles (more convenient than public transport and cheaper than a taxi) and carpooling.

A shift toward new urban business strategies can provide such benefits as a major savings in public budgets including health, environment or energy by providing more safety transport, less congestion and the higher rate of employment[4].

Mobility as a Service

The concept of "transportation" based on a modal approach is evolving into the wider concept of mobility based on a service approach, for instance Mobility as a Service (MaaS). Nowadays, society gives preference to the customer experience more than vehicle ownership recognizing the use of various transport modes. For many people the ownership of a private car is no longer a primary objective for travelling, especially in urban areas. This conceptual change will completely modify the mobility offer, as well as the payment of mobility services [9]. The emerging travel services (such as car- and bike-sharing, ride-sharing, etc.) will have a positive impact on urban mobility, as they permit to reduce the number of private cars and traffic congestion in dense urban areas [10]. MaaS objectives are to put the users, at the core of mobility services, offering them personalised mobility solutions based on their individual needs [11].

MaaS has three dimensions that should take place when planning the innovation activities: The technological dimension: data sharing, interoperability, standardization as well as connectivity and built-in sensors of smart devices; The behavioural impact: the way travel and logistics patterns change (e.g. for older travellers) and what is the potential modal shift; economic and policy dimension: including organizational and regulatory aspects. This might involve a change of roles of different players implicated.

[4] Eurostat figure. European Commission webpage on mobility facts and figures: http://ec.europa.eu/transport/strategies/facts-and-figures/transport matters/index_en.htm

Furthermore, according to Jittrapirom et al. [12], a MaaS has the following core characteristics: integration of transport modes, tariff option, one platform, multiple actors, use of technologies, personalisation, and customisation.

Integrated Mobility

Secondly, it is important to take into account the concept of integrated mobility. This approach enables connecting travellers from trip origin to their final destination using all transportation modes through the integration of barrier-free planning, design, infrastructure, technology solutions and personalisation [9]. The concept behind integrated mobility is that passengers typically use more than one mode of transportation. Travelers have different trip needs and often switch modes to suit their travel needs.

The benefits that integrated mobility can provide are:

- Combined mobility. Create a seamless travel experience for the door-to-door journey by integrating public and private transport modes in one single service, guided by an intermodal journey planner.
- One-stop-shop. Provide easier travel by combining journey planning, mobile ticketing and fare collection in one single application.
- Personalized solutions. Every traveller has her/his own travel behaviour regarding the travel purpose, final destination and time. Each traveller needs the flexibility to choose and adapt her/his individual package [13].

A good example of integrated mobility can be a Google Trip Planner that enables to identify the best route and smarter decisions of traveling [14].

The addition of alternative modes (transit, cycling and walking) to trip planning apps provide traveller with information to compare travel times, identify different travel routes and better navigate through the transit network. Therefore, technology plays an important role in providing valuable information that allows travellers to make smarter travel choices and should be an essential part of integrated mobility.

Shared Mobility

The Swiss Mobility Academy[5] defines shared (or cooperative) mobility as follows: *"Collaborative mobility focuses on sharing journeys, modes of transport, and infrastructure. In between collective and individual transport, new peer-to-peer based networks are emerging, boosting new types of individual mobility beyond private car ownership."*

Shared mobility, is part of the wider "collaborative economy" or "sharing economy" environment, defined in the European agenda for the collaborative economy as *"[a variety of] innovative business models where activities are facilitated by collaborative platforms that create an open marketplace for the temporary usage of goods or services*

[5] Mobility Academy, 2014, Wocomoco flyer (http://bit.ly/2lnIwkq).

often provided by private individuals"[6]. Service providers offer their goods, assets, or skills to a variety of users via a platform provided by intermediaries. "Sharing" has also become an urban mobility reality. Shared mobility prioritizes the importance of reaching destinations, often at a smaller individual and societal cost than by using a private vehicle. As shared mobility serves a greater proportion of local transportation needs, multivehicle households can begin reducing the number of cars they own while others may abandon ownership altogether, reducing future demand.

2.2 Innovative Business Models in Mobility Sector

It is now crucial to analyse what has been studied in the existing literature about the innovative business models in our sector of interest. Some researchers in the transport and mobility sector argue that the traditional organizational structure and Business model (BM) is no longer viable [15, 16]. Increasing challenges in the mobility sector such as market saturation, environmental issues (bad air conditions), congestion, accelerated urbanisation changing customers demand and needs forcing the mobility organisation to change their BM in order to address these issues. Changing market characteristics and fast evolving new technologies make LA to reorganize or even innovate their BM [17].

Technological breakthrough also enables to enhance the improvements and technological advancements in many areas of transport and mobility, e.g. alternative power trains, digitalization, automotive software and hardware, connectivity and smartphone technologies that are further influencing the growth of innovative BM in the transport sector. Abdelkafi et al., [15] argued that *"Technology innovations and business model innovations are strongly linked to each other. A business model denoted the way companies can make money out of a technology. No matter how the technology is innovative and sophisticated, it will fail, if it is not possible for market players to make profits from it"* [15].

Following this statement, it can be derived that emerging technological innovation of the transport industry should be accompanied by BM innovation.

[6] European Commission, 2016, Communication A European agenda for the collaborative economy http://bit.ly/2cFpEKq

Fig. 1. Technology Enhanced Urban Mobility Ecosystem

New mobility paradigm is changing the urban mobility sector providing new business models and the ways transport authorities deliver services. New business models regard the above described MaaS, Sharing and Integrated mobility services. Next sections will introduce the innovative business models and partnerships representing current innovative mobility trends.

3 Research Design and Methodology

In order to answer our research question a primary and a secondary data analysis were carried out to explore the economic viability and public acceptability of measures and assess the success factors and barriers that may accelerate or inhibit uptake to implement the innovative and sustainable urban mobility solutions in S-M cities.
Primary sources include a focus group and informal conversations with city partners. These meetings helped to understand the urban mobility situation in these cities and to identify the most relevant mobility services.
Secondary data collection includes a triangulation of official governmental documents of EU and other countries, publications from peer-reviewed journals, media publications, web sites and books, as well as open source reports and papers, to guarantee greater validity to the investigation.

4 SUITS Projects - goals and objectives

Previously in this paper we described the issues concerning the current mobility scenario and some new trends and solutions that are becoming popular in urban environments thanks to the wave of digital transformation positively affecting this sector.

The overall aim of SUITS project is to support the S-M cities in enhancement of their capacity to reduce congestion and air pollution, as well as to develop sustainable mobility in order to improve the urban mobility situation.

SUITS intends to achieve these goals by applying decision making support tools in developing innovative and sustainable financing, the implementation of schemes for innovative procurement, and providing innovative business models and partnerships.

Under SUITS Work Package 4 (WP) three Guidelines were developed in order to support local authorities in S-M cities to integrate new policies regarding sustainable transportation, including:

- Guidelines for applying Innovative and sustainable financing approaches.
- Guidelines for Innovative procurements.
- Guidelines for Developing bankable projects, new business models and partnerships.

The goal of these Guidelines is to provide an efficient decision-making tool that enables private and public mobility authorities/ stakeholders to improve the transport and mobility situation in their cities. Alba Iulia Municipality, Romania will test the ideas of three Guidelines.

After the finalization of all Work Packages nine partner cities (Coventry City Council, Stuttgart, Erfurt, Palanga, Rome, Valencia, Torino, Alba Iulia, Kalamaria) will integrate the know-how delivered by SUITS project including three Guidelines, the Pilot Application Report and the integrated tools. The project foresees also the training activities organized under different WP.

4.1 Innovative Public Private Partnerships

Some researches sustain that societies are governed by a combination of governing efforts by different kinds of actors and entities, public as well as non-public [18, 19].

Public-private partnerships (PPP) are well known to be powerful tools in carrying out transport and mobility projects. Public-private alliances are vital for the formulation and implementation of strategies in a mobility sector. Before introducing the Innovative Public Private Partnership (IPPP) it is necessary to present the PPP form explaining its benefits and challenges for mobility organisations.

PPP

Most EU member states and the European Commission regard the PPP as an important tool to attract additional financial resources for high priority investments such as transport. The European Commission gave the following definition of PPP refers to *"forms of cooperation between public authorities and businesses, with the aim of carrying out infrastructure projects or providing services to the public"* [20].

The public sector plays an important role in building urban transport infrastructure. However, the resources needed are much more than the public sector can provide and

public investment, however, have to be supplemented by private sector investments. In order to address this gap, this Section is focusing on providing the insight in the combination of public and private partnership and how this partnership can create a benefit for both urban mobility stakeholders.

PPP form an important part of the urban investment package (set of the presentation material and documents needed to obtain an investment). Many cities have PPP-specific departments to manage the role of the private sector in municipal service delivery, which tend to vary from city to city. PPPs can vary from basic service contracts with limited asset ownership, to mature fee-based build-operate-transfer (BOT) projects where the private sector has full responsibility for a project's operations and investment.

Among the benefits of using the PPP models, according to the EC[7] are: acceleration of infrastructure provision, faster implementation, reduced entire life, better risk allocation, better incentives to perform, improved quality of service, generation of additional revenues, enhanced public management.

IPPP

IPPP is a new form of partnership where the main actors are public and private organisations and other type of organisations like civil society organizations (CSOs), non-governmental organisation (NGO) or communities. These new forms of collaboration enable to identify the opportunities for the design and implementation of the long-term strategies for partnership. Each actor of the iPPPs has its important role in the alliance.

In the IPPPs public organisations are defined as an important actor who not only has a key roles of supervising, creating incentives and regulatory frameworks, but also developing new opportunities and governance mechanisms to enable the sustainable long-lasting collaboration with the private sector and other forms of organization, in order to optimize outcomes, impact and sustainability.

The private sector has a significant role in the partnership. It contributes to bring the investment and expertise in the alliance having its business for-profit orientation.

Finally, other important actors in this type of partnership such as NGOs, CSOs or communities may bring their expertise and vision of transport and mobility sector.

Transport and mobility sector can benefit from this new form of partnership by having on board not only the professionals of the mobility sectors but also other important actors that may be more familiar with the transport sector issues and needs. The last ones could provide their attitude on the situation and help to develop more effective measures to address mobility issues. The logic of iPPPs is that the transport and mobility issues should be analysed jointly, rather than separately, by governments, public and private sector and communities.

[7] http://ec.europa.eu/regional_policy/sources/docgener/guides/ppp_en.pdf

5 Innovative Business Models

S-M-sized cities operate in the situation where the mobility sector faces a great competitiveness, rapidly changing and uncertain economic environment that make local authorities (LA) to take complex and difficult business decisions. Transport and mobility organisations run their businesses in a digital era where new technologies innovate business models enabling to solve current mobility problems.

Many factors should be taken into consideration while starting a new business such as mobility business environment, strategic partnerships, technological innovation, market tendencies, revenue streams etc. Well-elaborated business model will enable the transport and mobility organisation to obtain the funds for its innovation exploitation and well-prepared feasibility study will prove the project financial viability. This final section briefly introduces new mobility services and their business models (BM) that can be used as fundamental tool to enable S-M-sized cities to create their mobility innovation strategies. The business model examples presented can contribute to the literature on this topic and be used as a cognitive model for mobility stakeholders who want to deliver these kinds of services in their cities.

5.1 Car on-demand

On-demand mobility is the integration of ride-sharing and ride-hailing services with transit operations. Car on-demand is an innovative, user-focused approach which leverages emerging mobility services, integrated transit networks and operations, real-time data, connected travellers, and cooperative Intelligent Transportation Systems (ITS) to allow for a more traveller-centric, transportation system, providing improved mobility options to all travellers and users of the system in an efficient and safe manner.

5.2 Micro Mobility

Micro mobility refers to a brand new category of vehicles that can become an alternative to traditional modes of transportation. Several types of micro mobility vehicles exist: personal transportation solutions, such as scooters/E-scooters, E-bikes etc. and small electric cars with one or two seats, electric vehicle (EVs). Micro mobility vehicles industry is developing rapidly. Consumer preferences are changing and BM are striving to analyse and meet the new needs of the modern customers. For instance, millennials generation is buying their first cars much later than previous generations. Small sized micro eclectic cars and personal transportation devices could be an attractive alternative to fossil fuel private cars.

5.3 Car Sharing

Car sharing is a service that provides customers with access to vehicles for short-term usually hourly use. The shared cars are distributed across a network of locations within a metropolitan area. Members can access the vehicles at any time with a reservation and are charged by time or by mile. Car sharing thus provides some of the benefits of a personal vehicle without the costs of owning a private one.

5.4 Ride Sharing

Traditional ride sharing includes carpooling (grouping of travellers into a privately owned vehicle, typically for commuting), vanpooling (sharing of a ride in a van by commuters traveling to/from a job centre) and real-time ridesharing services (matching of drivers and passengers based on destination, through a mobile app before the trip starts and through which the passenger pays a share of the trip cost).

Ridesharing essentially focuses on the issue of filling empty seats in vehicles, which helps better realize vehicle occupancy potential and reduces the number of vehicles on the roadway. Ridesharing can be a powerful tool to address problems of congestion, emissions and fossil fuel dependency

5.5 Bike Sharing

Bikes haring comes in multiple forms, including public, closed community and peer-to-peer systems. Bike sharing enables users to take short point-to-point trips using a fleet of public bikes distributed throughout a community. Peer-to-peer bike sharing allows users to rent or borrow bikes hourly or daily from individuals or bike rental shops. Bike sharing has the potential to play an important role in bridging some of the gaps in existing transportation networks, as well as encouraging individuals to use multiple transportation modes. The ultimate goal of public bike sharing is to expand and integrate cycling into transportation systems, so that it can become a daily transportation mode for commuting.

5.6 Parking

In metropolitan areas, parking management influences drivers search time and cost for parking spaces, parking revenue, and traffic congestion. The wide deployment of wireless parking meters with sensing and communications capabilities allows the parking

authority to monitor the state of each parking space in real time and optimize the parking management. Innovations on this sector could prove very helpful especially in small and medium sized cities, where due to the absence of several different modes of transport, citizens rely almost entirely to their private cars for transportation. Thus, parking problems may appear more often on these cities.

5.7 Public Transport

Public transit is publicly owned fleets of buses, trains, ferries, facilities etc., with fixed local routes and express services. It is a core of shared urban mobility. There is a great potential for transit agencies to integrate with or offer shared modes to increase access to transportation and lower costs. Both large technology companies and emerging app entrepreneurs are working to develop integration platforms that cross these modes.

5.8 Integrated Mobility

Integrated mobility is a technology-enabled strategic service to ensure that travellers have the most convenient possible transportation journey. Integrated mobility aims at connecting people and places.

6 Conclusions and Future Research

Cities are oriented to deliver sustainable solutions that can positively affect the lives of world's population, improving the climate situation regarding the air pollution, reducing a traffic congestion, developing more secure transport and providing economic and social benefits. On the wave of the digital transformation of the society, promising urban service innovations that already exist still need to scale up to their full potential for small and medium cities to fully realize the benefits of sustainable urban development. A successful implementation of investment programs requires shifts in traditional business models that bring public and private interests into alignment. New approaches to developing sound project pipelines are needed to smooth and accelerate the early stage investment process where important knowledge, capacity and interest gaps can exist.

Finding new business models, like those mentioned in the present work, to accelerate and scale up investment in sustainable urban mobility will depend on answering following key questions: what to invest in, how to pay for it, how to mobilize investment capital and how to structure implementation. To best answer these questions, the following key stakeholders need to develop sustainable solutions together: city decision

makers, service providers and investors should build a shared understanding of the challenges and opportunities of different business model choices to ensure cities meet their service objectives; infrastructure and technology providers satisfy their bottom line; and financiers make a return on their investment.

Despite this study can be useful for mobility stakeholders who want to apply the SUITS project findings and recommendations regarding new business models and partnership. A successful implementation of the guidelines will depend on the local governance and legislation, and the ability of public and private authorities to provide the resources for creation of new business opportunities.

The future research aims to provide an in-depth analysis of the new BM in the mobility sector and to analyse how the project cities managed to implement the proposed business models and what challenges they faced.

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Public organisations as technology-enabled communities

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Abstract. As organisation that embrace information technology and develop the potential of digital and interactive technologies looking at the ecosystem as *locu*s where value creation occurs, public organisations should adopt a service logic view becoming digital and smart institutions. Public organisations should rethink themselves as communities that support cooperation and enable public-private partnerships. Public organisations should encourage active involvement of citizens as co-producers of public services in order to drive and facilitate public value creation within public services ecosystems. Information and digital technologies help public organisations to promote inter-organisational, collaborative and cooperative processes and relationships, building smart communities that contribute to creating public value within society and ecosystems. Technology helps public organisation to emerge as an ecosystem that enables to develop public services delivery and quality, becoming digital and smart institution that uses technology for building partnership with citizens and businesses as a means to drive community to achieve sustainability. Technology helps to support public services co-production leading organisations, citizens and users to proactively act and co-design and co-work for engendering public value co-creation.

Keywords: Public organisations, smart and digital government, smart communities, co-production, sustainability.

1 Introduction

The advent of the Internet, the introduction and diffusion of information and communication technologies (ICTs) and digitalisation in government enable public organisations to rediscover themselves as communities that are oriented to public value creation relying on sustaining user co-production and promoting public-private partnerships within public services systems.

As institutions that express evolving values and preferences of communities, public organisations should promote the public interest by interacting with citizens as partners in the work of government, promoting cooperative processes between private, public and no profit organisations, opening to learning and change, sustaining civic engagement and collaboration in order to support community development [1, 2, 3, 4].

Citizens, business, governmental organisations and other stakeholders should contribute to actively promoting public value creation [5]. Public organisations should focus

on sustainability as a value and source that is driving decision-making and action in order to benefit people and communities within society [6]. As organisations that achieve sustainability through public value co-creation, public organisations should adopt a public service logic and follow the ecosystems perspective to development [7], enabling the service users to actively drive value creation [8]. Public organisations should promote and facilitate long-term cooperation with users to ensure better efficiency, quality and sustainability of public services driving the transformation of user knowledge and encouraging the service delivery process through co-production [9, 10, 11]. ICTs are changing the way people and business are interacting with government agencies [12].

Information technology helps public organisations to interact with citizens to drive services co-production, to design policy processes as a result of dialogue and shared values in order to sustain public trust in government [3, 13, 14]. ICTs and digital technologies are leading public organisations to become sustainable, lean and smart institutions and communities that encourage private-public collaborations, empower citizens as co-designers and co-producers of public services, and support innovation and knowledge development [15, 16, 17, 18, 19, 20, 21].

The diffusion of digital information technology is changing the way public organisations are interacting with citizens and business in order to promote value creation within society. The research question is the following one: are ICTs and digital applications changing public administration framework and driving public organisations to evolve as communities that contribute to enabling public value creation? The aim of this study is to elucidate how technology helps public organisations to become as communities that proceed as digital and smart social entities and organisms that sustain the co-production of public services and enable public value creation within social and economic ecosystems. The contribution of this study is to provide a framework in order to identify a pathway that leads public organisations as communities to drive value creation by using and developing the potential of information and digital technology.

The study relies on the analysis and review of literature in the field of public service organisations following a service logic view to value creation. This study aims only to provide an interpretive and qualitative framework. Referred journal articles were selected from *Google Scholar* as the main web source and database. The selected contributions are summarised and interpreted in a narrative synthesis in order to develop and present new perspectives on emerging issues and advance theoretical models [22, 23].

The paper is structured as follows. After the introduction, in the second paragraph the theoretical background is presented. Rediscovering public organisations from a logic service-oriented perspective is elucidated. In the third paragraph it is explained how technology helps public organisations to evolve as communities moving from being organisations to becoming ecosystems, adopting digital and smart processes in order to support private and public partnerships and sustain co-production of public services. Finally, conclusions are set out.

2 Rediscovering public organisations from a service logic view

Public organisations should rethink and redefine a logic service strategy and view by interacting with citizens as services users and co-producers and developing new forms of collaboration with other organisations and stakeholders. As organisation that contribute to social and economic value creation, public organisation should follow a service logic view in order to facilitate public value co-creation [8] relying on citizens that collaborate with governmental organisations, being active co-producers of public value [5] because public services systems concern human, organisational and technical elements [9, 10]. Public organisations should promote and facilitate long-term cooperation with users in order to ensure better efficiency, quality and sustainability of public services driving the transformation of user knowledge and encouraging the service delivery process through co-production [9, 10, 11, 24]. Public organisations should contribute to sustaining civic engagement and collaborative citizen-centred public management in order to develop policies for the welfare of community, promoting citizen involvement and engendering public trust [1, 25, 26, 27]. Public service organisations should support inter-organisational, long-terms and trust-based relationships in a plural and pluralist state in order to ensure better efficiency, effectiveness, quality and sustainability of public services, where multiple inter-dependent actors and processes contribute to defining and building public services delivery and policy making [10, 11]. As organisations that achieve sustainability, public service organisations should adopt a service logic view enabling the citizens and/or service users as the actors that create the performance and value of a public service and actively drive value creation [8]. Public organisations should consider: the public service as service promise shaping the expectations of this service by their users; the public service delivery as a relational and process-based phenomenon supported by digital technologies that help public organisations to follow a user-driven culture relying on service effectiveness and public value creation [8, 10].

3 How technology enables public organisations as communities

The Internet, new interactive and digital technologies help to design public organisations as digital and smart communities that drive economic and social change and contribute to innovation. Public organisations should use and develop the potential of information technology to sustain cooperation and collaboration with citizens as services users and co-producers promoting public and private partnerships. Information and digital technology helps public organisations to contribute to public value co-creation in order to facilitate and continuously encourage public services co-production, digital and platforms that enable exchanges between private and public organisations as communities that facilitate sources, information, knowledge sharing and development.

3.1 Technologies drive the transition from organisations to ecosystems

As organisations that promote value co-creation within community, public organisations are evolving from an organisational perspective to looking at social and business ecosystems [7]. Public organisations as ecosystems tend to enable private and public actors, civil society and citizenry to rediscover the community that benefits of information and knowledge sharing. ICTs and digital technology lead public organisations to define policies rethinking the way to interact with citizens, businesses and other stakeholders [12], opening to a data-driven culture in the public sector using digital platforms that enable allow to rediscover a community/citizen centred approach community [13, 14, 28]. Public sector organisations are using information technology in order to shape a network society where digital networking and ICTs enable the knowledge creation and information management [29]. New interactive and digital technologies help to design smart communities that rely on driving alliance and cooperation between private and public organisations to solve collective questions related to public interest [21]. Digital government relies on creating a digital ecosystem able to create public value by ensuring openness, inclusiveness, engagement and participation in policy-making and service design, strengthening cooperation in order to better serve citizens and businesses [30]. In embracing and using digital technologies, governments are becoming ecosystems of economic and social innovation and accountability that make sufficient quality and useful data available and accessible to citizens, consumers and businesses [31], enabling people to do most of the work and create future public services delivery and production [32, 33]. Building public digital and open ecosystems relies on designing a network by combining expertise and emerging resources in the market and civil society [34], sustaining participation and collaboration, driving the evolution of technology, organisations and institutions [35].

3.2 Sustaining technological evolution: from digital to smart public organisations

Information technology applications help governments to interact with citizens, businesses and other local or national governments. As institutions that are going digital, public organisations are becoming lean and smart organisations. ICTs contribute to empowering social and political interaction and strengthening cooperation and citizen participation [36]. Technology helps support agile government and digitisation processes leading public organisations to proceed towards a digital era governance [28]. The evolution and maturity of e-government models follows a citizen-centred view coherently with an increase of technological and organisational complexity and in virtue of complete integration increasingly emphasizing the role of citizen as a user of governmental services and move towards a digitalisation of the core activities as beneficial for the end-users [37]. Public organisations should drive digital evolution that enables interactions within communities: digitisation has not any transformational impact on government; transformation helps to modify internal organisation; engagement helps to redefine external relationships with government stakeholders; contextualisation has transformational impact on sectors and communities. Some variables drive digital evo-

lution of government: digitisation can transform or not the internal workings and structure; transformation driven by digitalisation can affect or not the relationship between governments and customers, and depend or not on a particular context or country [38]. Promoting digital innovation helps public organisations to adopt a smart approach developing external and internal processes, providing information and knowledge sources within smart communities that evolve through coalitions between private and public organisations [21]. Digital technologies help public organisations to enhance public service effectiveness, support interaction between government and citizens, encourage participation in decision-making and promote social equity and socio-economic development [15, 16, 17, 39]. Digital technologies enable public organisations as lean and smart institutions that support private-public collaborations, empowering citizens as co-designers and co-producers of public services, sustaining innovation, citizen-centricity and knowledge [18, 19, 20, 21, 40].

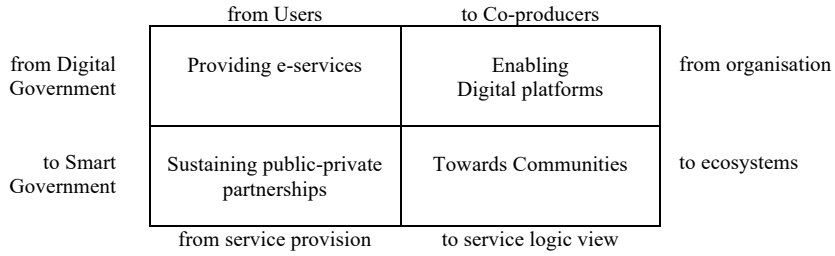
3.3 Sustaining co-production of public services for value co-creation

Public value is enjoyed by citizenry even more if citizens are called and want to co-produce. In the public sector, the primary concern in dealing with service-users is to encourage 'willingness to co-produce', that is to provide time and effort to participating in production of public services [41]. Users and community co-production drive all the stakeholders to influence outcomes and contribute to interdependence of decision-making. Co-production relates to the role of the users and community that contribute to providing sources in service co-production [12]. Co-production places the experiences and knowledge of the service user at the heart of effective public services system [10]. It helps citizen engagement as source of effective performance and innovation in public services [23]. Co-production as a lens for looking at value co-creation following many ways in terms of co-design through active involvement of user and co-innovation as related to the service system. It relates to the voluntary or involuntary involvement of public service users and relies on building partnership and collaboration with citizens as services users and co-producers [42]. Promoting smart communities enables citizen involvement and participation in services co-production [43]. Co-production as a key source for effective performance and innovation stresses social exchange, helps social inclusion and citizen engagement [10]. Information and digital technology help public organisations to rediscover networked coproduction of public value coherently with a community/citizen centred approach that enables citizens to interact with government agencies enriching decision making and benefits more people than those directly participate in the process [13, 14, 28]. Internet-enabled collective co-production tends to value the role and capabilities of citizens opening up new channels for collaboration. New technologies are empowering the citizens as responsible partners in public services delivery and in the work of government [44].

4 Discussion

The Internet, digital and interactive technology are leading public organisations to rediscover the community as a source and framework that enables public value creation that relies on sustaining digital and smart government, driving public organisations to be ecosystems for innovation and exchange and sustaining services co-production of services promoting information and knowledge creation and sharing, new forms of collaboration between individuals and groups, private and public companies.
As shown in figure 1, the main contribution of the study is to provide a framework of analysis in order to identify a pathway that is driving public sector and services organisations to use and develop the potential of information technology to become communities that are oriented to public value creation and wealth within society.

Fig. 1. Towards public organisations as communities: a framework of analysis



As organisations that are oriented to achieve sustainability as a value that orients action and decision-making for value creation within society, public sector organisations should employ technology and relational sources in order to facilitate public value co-creation by continuously driving innovation and supporting cultural and strategic change within communities, looking at social and economic ecosystems perspective, strengthening the active role of citizens as co-producers and proactive co-designers that are involved in co-innovation process and co-design.
As organisations that are going digital by interacting with users and/or co-producers, public organisations develop the potential of technology to provide e-services or designing digital platforms that contribute to facilitating transactions and ensuring high services quality. As organisations that promote digital innovation and modernisation in processes and services delivery tend to provide only e-services and promote e-government initiatives that enable the citizens as merely services user following a service provision and organisational view to public services design and strategy.
As organisations that follow a service provision view within public services systems, public organisations as smart institutions strengthen cooperation, information and knowledge exchange encouraging public-private partnerships. As organisations using ICTs for managing information, public organisations behave as smart organisations that

contribute to public value creation embracing a digital view to using technology in government and following a system perspective to managing and delivering public services where citizens and other stakeholders are users and beneficiary of public services delivery and production. As organisations that adopt a service logic view, public organisations should embrace and use digital technologies to design lean and smart communities that engage citizens as active participants, co-producers, co-designers and co-innovators encouraging private-public partnerships and cooperation that enable knowledge sharing and creation through digital platforms that foster active participation in public services delivery and production, in policy making as sources for creating public value. As smart and digital organisations, public organisations become communities that drive social and economic growth by encouraging public-private partnerships within digital-enabled ecosystems in order to create sustainable and shared, social, economic and public value. Some policy implications tend to emerge.

5 Conclusion and future research

Sustaining public value creation within society relies on involving public organisations, private companies, no profit organisations and associations, individuals and groups that identify new forms and patterns of collaboration oriented to provide benefits for people and organisations. The advent of digital and interactive technologies enables public organisations to become as smart services institutions that adopt a service logic view following the ecosystem perspective as a framework to drive and facilitate public value creation within society. Digitalisation and modernisation of public administration can help the development of innovation and change within institutional and legal framework in order to stress forms and rules of democratic participation and engagement that encourage people and organisations to live *res publica* coherently with a vision of a community that relies on shared vision, common cultural and ethical values of public servants and citizens that cooperate for conducting life and business following a value-driven view. Technological and digital advancements contribute to making public organisations more open and transparent in designing and structuring processes that enable cooperation and collaboration that involves private companies, no profit organisations, civil society and other stakeholders that are interested to co-produce new services and knowledge and support processes of innovation and public value creation within communities. In this study some limitations tend to emerge. The analysis does not provide empirical analysis and case studies but contributes to identifying an interpretive pathway to understand how public organisations going digital tend to evolve and develop as communities oriented to ensure better quality of life for people and high quality of public services and democratic issues. Future research perspectives imply to further investigate how the advent of digital and interactive information technology helps local governments to re-arrange and re-structure organisational design that opens to involvement of local stakeholders (individuals, groups, associations, business, etc.) in order to adopt a community-centred approach following a service logic view improving public services systems interacting with citizens, small and mediums size businesses, citizens,

profit and no profit organisations and associations to stimulate innovation and learning driving processes of public value co-creation.

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A Research Framework for Social Network Analysis

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Abstract. Social networks are a valuable source of information for applications spanning from business to politics, to security, to social good. However, studying social network features, like psychological attitudes of members and phenomena, like the evolution of groups and spreading of ideas and fake news, requires multi-disciplinary scientific skills that are not easy to acquire in the job market. Therefore a further effort is required to exploit such knowledge and create business or social value. In this context we propose a conceptual model to represent social networks and a research framework based on behavioral science and design science to deal with them. The framework has two goals: giving an overview of scientific foundations for social network analysis and providing some guidelines for social network research. A discussion on the practical implications of the proposed framework closes the paper.

Keywords: Design Science, Behavioral Science, Social Networks, Research Framework.

1 Introduction

Availability of huge amounts of data on people in social network platforms as Twitter and Facebook allow to build software and services able to create new business, research and social opportunities. Examples of applications are recommendation systems based on user profiling, tailored electoral campaigns, and analysis of terroristic networks.

Despite these opportunities for enterprises, scientists and governments there is a lack of personnel able to deal with the complexity of the analysis required to get insights from social network data [41]. In fact social network analysis requires to face issues as modeling psychological attitudes of members, describing and predicting evolution of groups and spreading of ideas and news. Required skills span from STEM disciplines, as computer science, engineering, mathematics and physics, to business, to psychology, to sociology [20]. Several of these competencies are necessary to create business and social value [55]. Furthermore building and managing a multidisciplinary team is not easy from an organizational perspective.

In this context the goal of this paper is to build a better understanding of professional skills needed for social network analysis and organize the scientific activities concerning this sector in a research framework. To this purpose, first we describe a

conceptual model to represent social networks knowledge. Then we present an overview of scientific and technological foundations for social network analysis. Finally we propose a scientific framework based on design science and behavioral science [31] to deal with social networks (SN)s. The final goal is to provide some guidelines for social network research. It is worth to note that both the conceptual model for SN knowledge and the above-mentioned overview are fundamental aspects in the proposed framework. In fact they represent, respectively, the design (abstract) artifacts of SN research and the knowledge base including existing methodologies and theories needed to make research in this multidisciplinary field.

The research framework was already adopted to organize the work to get insights from scientific social networks. Achieved results concern estimation of susceptibility and authority of social network members [17], assessment of gender diversity [19], and assessment of how differently same people behave and interact with others in different communities [18].

The rest of the paper is organized as follows. Section 2 presents the related work in the area. Section 3 presents the conceptual model for social network knowledge. Section 4 gives an overview of the disciplines related to social network analysis. Then the research framework is presented in Section 5. Finally Section 6 closes the paper with a discussion on the practical implications of the proposed research framework.

2 Related Works

Research frameworks for Information Systems (IS) drive the way of doing research in this field. Among the most important contributions we cite action research presented in [6], the research frameworks investigating the role in IS research, respectively, of natural science and design science [37] and behavioral science and design science [52], the design science research methodology for IS research proposed by Peffers et al. [45], and the description of the structural components of design theories in IS presented by Gregor and Jones in [28].

Close to the domain of social networks, Chen et al. [15] present a framework that identifies the evolution, applications, and emerging research areas of business intelligence and analytics. Then Gandomi et al. [25] give an overview of big data research by focusing, in particular, on big data analytics. The authors classify it as text analytics, audio analytics, video analytics, social media analytics, and predictive analytics. Bello-Orgaz et al. [9] address the research domain concerning social networks, social media, and big data paradigms and describe the used methodologies mainly from a technological perspective. Finally Guo [30] and Fan and Gordon [22] present full-fledged practical methodologies to deal respectively with big data and social media data.

Most of these works address topics related to social networks and provide a structured understanding of the research domain. With respect to them we distinguish between the addressed environment, the research outputs and the achieved results and we present how they are connected.

3 A Conceptual Model for Social Network Knowledge

In this Section we present a conceptual model to represent knowledge concerning social networks. To this purpose the model shown in Fig. 1 was developed.

We refer to a Domain of Interest (DoI) characterized by a set of products. It is worth mentioning that the term *product* here is employed in its broad sense, referring not only to goods, but also to ideas, cultural events and scientific products such as articles, books, etc. Conceptual images of products can be expressed in terms of a finite number of *concepts* belonging to a *semantic network* representing the DoI.

Given the semantics structure, we further assume that there exists a set of elementary concepts, that we name *topics*, such that each product (or its abstraction) can be associated with a subset of topics.

The identification of this set of basic topics plays a fundamental role and is a critical issue for the ontology engineering discipline; the latter involves both automatic procedures (such as natural language processing) and human validation.

Then a *social network platform* can support the activities of a *real social network,* which is composed by *social network members* connected together.

Social Network members have *interests* in topics. Such interests vary with *time* (e.g., year) and can be estimated by means of a measure (i.e. degree of interest), which is inferred by *expressions of interest* of SN members as tweets, posts or published papers. Expressions of interest are events (e.g., publishing a post or a paper) demonstrating a positive attention by a member to a product. An expression of interest could contain an overall opinion towards the subject matter [43] (e.g., a specific product) that is here represented by the *sentiment* concept. Then the *veracity* concept represents the conformity with truth of an expression of interest as it can be true (e.g., something really happened) or fake (e.g., fake news).

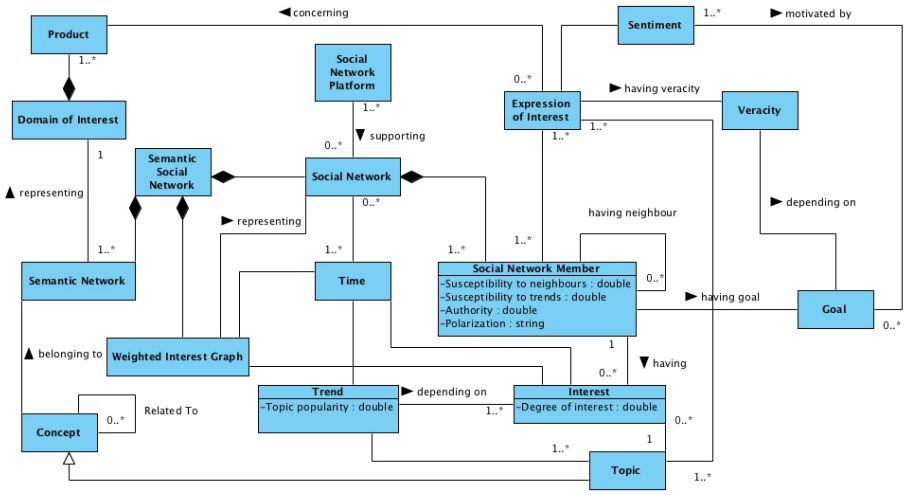

Fig. 1. Conceptual model for representation of social network knowledge depicted as UML (Unified Modeling Notation) class diagram.

Trends depend on time, e.g., they can be determined every year by analyzing all the interests in topics of SN members.

The individual features characterize SN members with respect to the specific domain of interest. The susceptibility is an individual feature of a social network member that represents the state of being easily affected, influenced, or harmed by something. *Susceptibility to neighbours* measures individual susceptibility from friends whereas *susceptibility to trends* measures susceptibility from the environment. Other individual features are the *authority,* i.e. the power to influence or command thought, opinion, or behavior, and the *polarization*, representing the tendency of a person in having extreme positions.

A SN member could have goals. The sentiment and the veracity of an expression of interest could depend on them.

Then we introduce a *semantic social network* consisting of a social network, a semantic network [49], and a weighted interest graph connecting them.

A *Weighted Interest Graph* represents an abstraction of a community of people together with their interests with weight (i.e. degree of interest) assigned to the interests of people on topics. Such links may be viewed as either the probability to be interested or the degree of interest in a topic.

Semantic social networks are dynamic entities: they are born, grow, shrink and, finally, die (close). Appearance of new nodes may describe both inclusion of new members or emergence of novel topics. Similarly, disappearances of nodes may represent the cease of participation of people to the community or the obsolescence of topics. Moreover interests of members on topics may change their intensity during the time.

4 The Multidisciplinarity Requirement

The increasing amount of data and computational power and the rise of social network platforms have caused the interest on social networks of a huge number of researchers from different fields.

Currently, different models, methods and tools are available and almost ready for the market. Thus this Section gives an overview of this field from a multidisciplinary perspective. First it presents how knowledge encompassing social networks is represented from a structural perspective, then it describes the existing research contributions on dynamic processes on social networks and, finally, the enabling tools that are available for social networks analysis. Fig.2 depicts the different scientific and technological foundations that are required for building business applications of social networks.

4.1 Knowledge Representation of Social Networks

Graph Theory

Social networks are systems potentially composed by a large number of highly interconnected dynamical social entities. The first step to identify the global properties of

such systems is to model them as graphs, where nodes represent the dynamical entities and links the interactions between them. The basic notions of graph theory, as the adjacency matrix, the degree of a node, the shortest path, the betweenness and the clustering coefficient, were already deeply investigated in the past [10].

An application of graph theory to analyze topological characteristics of huge online social networking services is presented by Ahn et al. [2].

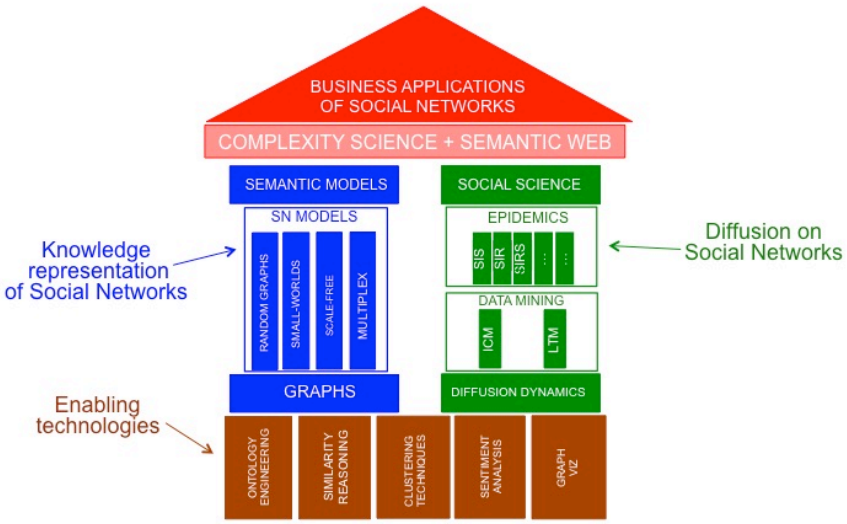

Fig. 2. A pictorial representation of some of the most relevant disciplines required for social network analysis.

Social Networks Models

In the last two decades social networks have been studied as examples of complex networks, i.e. networks with a size ranging from thousands to billions nodes, whose structure is irregular, complex and dynamically evolving in time.

The complexity science community has proposed general models, which are also suitable for other types of networks including biological networks and technological infrastructures (e.g., energy networks). They are able to mimic the growing mechanisms of networks and to describe some emergent structural properties. This approach originates from the seminal papers of Watts and Strogatz on small-world networks in 1998 [53] and of Barabási and Albert on scale-free networks in 1999 [7]. The *Watts and Strogatz model* [53] is a method to generate graphs, which are assumed to be neither completely regular nor completely random.

The degree of a node of a network is the number of its links with other nodes. A scale-free network is a network whose degree distribution follows, at least asymptotically, a power law. There exist several models to generate scale-free networks. Among these, the Barabási-Albert (BA) model [7] is an algorithm to generate scale-free networks based on growth and preferential attachment. It was inspired by the

growing mechanism of the World Wide Web where sites with high degrees acquire new links at higher rates than low-degree ones.

Then multilayer networks describe systems interconnected through different types of connections. Each type is represented on a layer and the same node or entity may have different kinds of interactions [11]. Multiplex networks are multilayer networks in which the same set of nodes interact through different networks. Social networks are multiplex networks, since one can consider several types of different relationships between members: friendship, coauthorship, vicinity, fan of the same football team, partnership or colleague.

Semantic Modelling of Social Networks

Research works concerning semantic modelling of social networks aim at providing a conceptual representation of people relationships, their activities and the objects that are either produced or discussed or shared in the network.

The precondition for this modelling approach is the availability of an ontology. An ontology is an explicit and formal specification of a shared conceptualization [29] [12]. A domain ontology, in particular, addresses a specific domain of interest by providing the scope of a specific subject matter or set of activities pertaining to a given application. Lytras et al. [36] propose ontologies, as the FOAF (Friend Of A Friend) [13] ontology, to provide a semantic description of profiles of social network members and related information.

In [40], Mika presents a tripartite graph with hyperedges to model networks of folksonomies[1] at an abstract level. This consists of three sets of disjoint nodes representing, respectively, actors (users), concepts (tags, keywords) and annotated objects (bookmarks, photos, ...). Like users tag objects with concepts, ternary associations, named annotations, can be created between the user, the concept and the object. Thus the folksonomy is defined by a set of annotations and it can be represented as a tripartite hypergraph with ternary edges, where each edge represents a given actor associated to a certain instance with a certain concept.

In [33], Jung et al. define the semantic social network as a structure consisting of the following interlinked networks layers: a social network layer, to represent people and their relationships; an ontology network layer, to represent networks of ontologies and their relationships; and a concept network layer, to represent concepts, their ontological relationships and implicit similarities. The links between the networks indicate that people use ontologies defining or referring to concepts and allow to infer relationships from one layer to another (e.g., regarding people similar if they use similar ontologies).

In [16], Cucchiarelli et al. propose a methodology and some tools to extract automatically the relevant topics shared among community members from documents and to study how the collaboration themes evolve in a scientific network.

In [39], Middleton et al. face the problem of recommending new items (i.e. research papers in the presented case study) to users, starting from their profiles. In particular, they propose an ontological approach to user profiling that leverages on

[1] A folksonomy is a practice of collaborative categorization using freely chosen keywords.

ontological inference. In that case, user profiles consist of both a set of topics and interest values in them. Recommendations are based on correlation between users' topics and classified research papers.

4.2 Dynamic Processes on Social Networks

Epidemics and Diffusion Dynamics

Among the phenomena treated by the complexity science, epidemics [51] studies the spread of viral processes in networks. Here the focus is mainly on human infectious diseases and software malware spreading.

However there is a growing interest in studying topics and gossip diffusion in social networks [54] and in social dynamics [14], [24].

Several epidemic models are available. Most of them model the status of a member. Among them we cite the SIR (Susceptible, Infected, Removed) model [51], the SIS (Susceptible, Infected, Susceptible) model [51], and the SIRS (Susceptible, Infected, Recovery, Susceptible) model [32]. Recently, epidemic spreading in multiplex networks was treated by Granell et al. in [27].

Propagation of information in social networks was studied in [8]. Here the authors show that, even if stronger ties are individually more influential, weak ties are responsible for the propagation of novel information. Diffusion dynamics on multiplex networks was studied by Gomez et al. in [26].

Influence diffusion and influence maximization in online social networks with both friend and foe relations are studied by Li et al. in [35]. Finally effects of homophily (i.e., the tendency for individuals to choose friends with similar tastes and preferences) in information diffusion cascades are presented by Anderson et al. in [3].

Data Mining Perspective

In [47], Richardson et Domingos propose a data mining approach to study the chain propagation of events (e.g. threads) in social networks and to identify leading influential members. Most of the efforts in the data mining community have been devoted to define progressive models. In such models, once a member becomes active (i.e. interested in a topic), it remains active.

The most important propagation models are the Independent Cascade Model (ICM) [34], where diffusion events along every arc in the social network are mutually independent, and the Linear Threshold Model (LTM) [34], where members adapt their behaviour upon exposition to multiple independent sources.

Social Science Perspective

Social science is devoted to study social influence and susceptibility of individuals belonging to different groups of people (e.g., students and housewives in [44]).

Recently a social science study was presented by Aral in [5]. There, the authors describe an experiment performed on Facebook to estimate influential and susceptible members of social networks with respect to some social features, such as age and sex. Another interesting issue considered by the social science community is homophily [5]. Homophily is considered as a confounding variable that can induce statistical

correlation between the actions of friends in a social network. Separating influence from homophily is the same hard statistical problem of separating correlation from causality. This problem was systematically studied by Anagnostopoulos et al. in [1].

Enabling Methods and Technologies

In this Section we present some of the scientific building blocks used to build the here presented software application for influence assessments in social networks.

Ontology engineering is a discipline that can support identification of the topics, the members of a social network are interested in, and their semantic relationships.

Several methodologies have been defined with the aim of identifying the steps, the needed competencies and the tools to build ontologies. Among them, UPON-lite [21] and NeON [50] define complete processes for the collaborative development of ontologies.

Natural language processing (NLP) [38] is a discipline that provides methods and tools to analyze and understand raw textual information and oral communications (after a speech recognition step). A fundamental notion at the basis of NLP is the language. This is defined as a set of strings over a finite alphabet consisting of symbols. Most of the NLP techniques are based on the statistical analysis of a text. Among them, the most critical for social networks applications are clustering, which is the process of grouping a set of entities, as topics or people, into classes of similar entities [38], word sense disambiguation [42] and sentiment analysis, which is defined as the task of finding opinions of authors about specific entities [23].

Word sense disambiguation, in particular, is the ability to determine computationally which sense of a word is activated by its use in a particular context [42]. It can be considered as a classification task where word senses are the classes and an automatic procedure assigns word occurrences to them based on some evidences from the context and from external data sources. In social network, this problem is relevant since there is the need to disambiguate both topics related to different fields and person names.

Similarity reasoning is a technique devoted to compute how much two concepts are semantically close. Many different techniques exist. Most of them are based on the notion of information content that is based on the probability of finding a concept in a given corpus [46]. When the likelihood of a concept increases, the information content decreases. The more abstract a concept, the lower its information content. Resnik defines similarity as the information content of lowest common subsumer. A lowest common subsumer is a concept in a lexical taxonomy, which has the shortest distance from the two concepts compared. The idea is that the more information two concepts share, the more similar they are.

5 A Research Framework for Social Network Analysis

To cope with social networks complexity, we defined a research framework starting from the information systems research framework presented by Hevner et al. in [31]

and based on the behavioral science and design science paradigms. Fig. 3 shows a sketchy representation of the framework.

According to Simon [48], the *environment* defines the problem space where the phenomena of interest reside. Here, it consists of the social networks, i.e., the entities where the dynamic phenomena take place, and the stakeholders, e.g., marketing companies, intelligent agencies, security agencies, and political parties. The environment defines the business needs and, consequently, the research objectives. Furthermore, it provides the relevance of the work to be performed.

In such a context, the social network research has two complementary phases. Behavioral science focuses on building and justifying new theories (e.g., the interest propagation theory) explaining or predicting social network phenomena by means of an experimental evaluation. Design science focuses on building and evaluating artifacts, as models (e.g., ontologies, social network graphs, semantic social networks), methods (e.g., semantic profiling, psychological features estimation), and instantiations (e.g., software applications). As stated by Hevner et al. in [31], the goal of behavioral science is truth whereas that of design science is utility.

The *knowledge base* consists of scientific foundations and methodologies. It provides the basis for the IS research. In this work, foundations are theories and artifacts related to complexity science, graph theory, semantic web, knowledge representation and big data; methodologies are the guidelines to be used in the justify/evaluate phase, i.e. natural language processing, data analysis techniques, statistical analysis methods, software programming, High Performance Computing techniques, machine learning theory, and deep learning. If IS research provides results, new foundations and methodologies are added to the knowledge base.

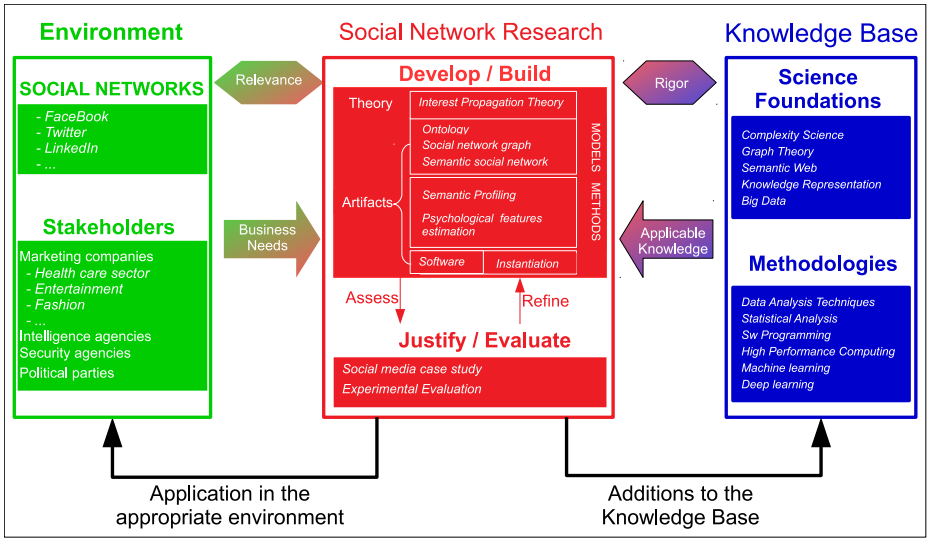

Fig. 3. Research framework for social network analysis based on behavioral science and design science.

6 Conclusion

Studying social networks requires multi-disciplinary endeavors to get insights from structured and unstructured data available, for instance, in social media platforms. These efforts require technical competencies concerning software programming and database management, modeling competencies, both from the mathematical and conceptual point of view, and domain-specific competencies depending on the addressed sector (e.g., health or security). In this work first we presented a conceptual model to clarify the social network concept (Fig. 1), then we gave an overview of the needed disciplines to face a social network analysis project (Fig. 2) and, finally, we presented an overall research framework (Fig. 3).

The research framework was originally conceived to be used in different sectors as business, politics, security, and social good. Managers or research directors can use it to organize the activities of a project, for instance, by choosing the most appropriate human resources devoted to develop a prediction theory, build a conceptual model or implement a software application.

As future work we aim at further enriching the description of the knowledge base and at analyzing scientific papers in the field of social network to better understand which are the most relevant topics among those here presented.

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Crowdsourcing platforms as multivocal inscriptions? How open innovation intermediaries (could) address tensions between co-creation actors

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Abstract. This study explores the role of crowdsourcing platforms as multivocal inscriptions, that is, collaboration-enabling artifacts that can be compatible with the practices, logic, and skills of different categories of actors. The case of a crowdsourcing intermediary in the fields of industrial design, craftsmanship and interior design confirms the importance of an intermediary organization that manages the platform and bridges people, "crowdsourcers" and "crowdsourcees", on the other side. In addition, this study leverages the case study to inductively develop a model of multivocality in crowdsourcing platforms. According to this model, a two-level multivocality (operational and strategic) is needed to address the fragilities of crowdsourcing; operational multivocality concretely enables collaborative interactions, whilst strategic multivocality aims to link the different goals and preoccupations of the two cath. This study contributes to the exploration of the complex dynamics that shape cooperation in crowdsourcing activity systems.

Keywords: Crowdsourcing, Open innovation, Multivocality, Organizational change, Value co-creation.

1 Introduction

Crowdsourcing does not have a univocal definition. Among the many, it has been defined as "*the act of a company or institution taking a function once performed by employees and outsourcing it to an undefined (and generally large) network of people in the form of an open call*" [13]. Crowdsourcing initiatives are characterized by an organization that proposes to complete a task, a crowd that will perform it, an online platform that allows crowdsourcing interactions and enables coordination, and the (expected) benefits for the subjects involved in the initiative [14][15]. The phenomenon has grown in popularity over the last few years: Waze, Lego DesignByMe, TripAdvisor, Indiegogo, Twago, Starbytes, Zooppa, BestCreativity are a few examples. Through crowdsourcing, a lot of brands found new and interesting ways to get their audiences involved [16]. Crowdsourcing can be potentially used in every working context, but it is especially applicable in creative fields. Contests have always existed in creative

sectors, i.e. for architecture projects, but digitalization dramatically increases the range of possible relationships between an organization and possible external contributors. Crowdsourcing, indeed, leverages ICT to outsource tasks to a 'crowd', rather than to a designated 'agent' (e.g. an organization, a team, or an individual). Crowdsourcing can be considered a web-based distributed problem-solving and production model, through which producer organizations ("crowdsourcers") directly benefit from inputs provided by external people ("crowdsourcees") and, at the same time, external people satisfy their intrinsic motivations through the participation in a community of contributors. A platform connects the involved subjects and enables crowdsourcing processes, for example by setting deadlines, expected results, and rewards for winners. Also, a company's (potential) customers and/or suppliers can become *crowdsourcees*, thus providing even small enterprises with fresh, market-oriented innovation capabilities that would be hardly affordable otherwise.

Despite these advantages, crowdsourcing has also some weakness and can give rise to mistrust and criticism. For example, enterprises may perceive crowdsourcing as a threat to the confidentiality of their industrial secrets, whilst c*rowdsourcees* may perceive crowdsourcing as a means of unfair labor exploitation. However, very little is known about these phenomena; in particular, the role of the platform, in enabling the integration between *crowdsourcers*' and *crowdsourcees*' goals, logic and preoccupations, is quite under-investigated yet.

The concept of "multivocal inscription", which has been recently developed by the management literature [2], could be usefully adopted to address this issue. A multivocal inscription is an artifact (e.g. a procedure, norm, discourse, or guideline) that is understandable, acceptable, and usable by different subjects belonging to different communities with possibly different logics, thus enabling coordination across diverse network actors without requiring (continuous) explicit consensus and/or direct interaction. The crowdsourcing platform could be then viewed as an inscription for value co-creation that is expected to be used by actors with very different knowledge bases, values and beliefs, such as large, medium, and small-micro enterprises in different sectors, experienced and unexperienced free-lance professional *crowdsourcees*, firms interested in new B2B relationships, students, amateurs and brand lovers all around the world. In this light, a key mission of crowdsourcing intermediaries would be the build-up of a digital platform that serves as an effective multivocal inscription, enabling coordination and mutual satisfaction of these diverse groups of actors.

This study explores the (possible) role of crowdsourcing platforms as multivocal inscriptions, by investigating the case of a crowdsourcing intermediary in the fields of industrial design, craftsmanship, and interior design. The case confirms the importance of an intermediary organization that manages the platform and bridges the *crowdsourcers*, on the one side, and *crowdsourcees*, on the other side. In addition, this study leverages the case study to inductively develop a model of multivocality in crowdsourcing platforms. According to this model, a two-level multivocality (operational and strategic) is needed to address the fragilities of crowdsourcing; operational multivocality concretely enables collaborative interactions, whilst strategic multivocality aims to link the different goals, logic and preoccupations of *crowdsourcers*, on the one side, and c*rowdsourcees*, on the other side.

2 Background

2.1 Crowdsourcing

Open innovation arises from specific conditions: work mobility, internal R&D, technological base, border roles to integrate different parts of organizations and rules to guarantee intellectual property, especially if major investments are necessary in order to guarantee remuneration for investors [1]. Therefore, social media, in particular collaborative projects, blogs, and social networks, may play a generative role [4]. Participation in the community allows knowledge exchange and co-creation across the members of the network [5]. Moreover, social media may make involved people more receptive, i.e. more attentive to external stimuli that translate into ever-greater and different knowledge, far beyond the boundaries of business systems. By increasing competence, indeed, social media can be a key to improvement and innovation [8]. Participants have different orientations, ideas and perspectives, so generate interdisciplinary inputs [5]. Reduction of hierarchical layers is another benefit; control moves from manager toward the whole organization. Consequently, the managers' role changes; they will have the task of moderating and defining a general direction, providing feedback to structure the work itself and made workers on several projects safer [5].

Crowdsourcing is particularly useful if companies want to innovate and do not have the necessary knowledge, or if do not consider strategically convenient to develop internally. The contribution of external people allows exploiting their personal resources and knowledge to develop innovative ideas both through individual research processes [15][17], and thanks to new perspectives and structures, cognitive effects that can positively influence problem-solving. In addition, the resolution times, risks and costs associated with the problem-solving process are reduced [15]. The success of crowdsourcing initiatives depends on the participants' creativity, favored by social networks, as this can increase reach, depth, and speed of access to knowledge. It depends also on participants' experience of "learning by doing", and their ability to integrate the accumulated knowledge with the already existent in one's cultural background [20]. Users' ability to creating very valid ideas is the real value and effectiveness of crowdsourcing. Many studies showed that users are actually competent in developing truly innovative ideas [21], as they often innovate for themselves to cover the personal need, hence they have a high commercial attractiveness [17][22].

The importance of R&D and technological knowledge remains, in order to ensure implementation of ideas, however, it must not rely only on it. Additional exploitation of internal knowledge, in fact, will lead to a decline in the number of new products beyond a specific point [24][17]. Knowledge and experience influence professional developers, and divergent thinking, in order to create new solutions, is difficult. Users are not hampered by such concerns regarding technologies and can realize original ideas respecting professionals, who are more focused on how to implement the idea and transform it into an effective product or service for the market rather than on the idea itself. Professionals' ideas hence are less innovative but more easily achievable than users' ones; on the other hand, users can better solve needs-based problems and be less efficient in technology problems [17].

The effectiveness of solutions may depend on people's education and skills, sector, categories of products to be innovated [15]. The more complex the sector (or products), the more difficult and expensive it will be to attract users who are truly able to collaborate. Users want to solve problems, driven by needs or desires such as money, altruism, working on an interesting project, building a reputation, showing their skills or acquiring others for future work, belonging to a group etc. [26]. The setting of crowdsourcing platforms also influences results. Orientation can be collaborative stimulating people to relate to each other and share notes, comments and criticisms about others' proposals in order to improve quality of solutions through continuous feedback and connections with new perspectives [30] [17]. On the other hand, it can be competitive, limiting interaction and value co-creation but favoring competition.

Open innovation uses social media in several stages. Firstly, in the ideation phase, when enterprises are looking for new ideas for products or projects: social networks can reach as many users as possible and direct them to a crowdsourcing platform of the external organization. On this platform, participants can collaborate, review and vote on others' ideas; prominent ideas emerge naturally by eliminating the least attractive [38]. The re-elaborating process of existing ideas carried out by successive generations, increased the quality of ideas despite the difficult identification of reference target due to few regulations and little control of social media. Secondarily, in the R&D phase, the analysis of social media applications can provide companies with totally new and free opinions from current consumers but also potential ones that can lead to a successful launch of new products [10]. Opinion polls, competitions, and images are the main useful tools to market exploration and development of new products. At this stage, there are more problems than at ideation phase; the lack of internal skills prevents to analyze the extensive data on social networks and the rigid organizational culture and a hierarchical structure impede to embrace social exploitation [38]. In the first case, a specialized external company can solve problems; in the latter, a decentralized inter-functional team can manage the social media strategy, creating flatter structures and reducing the bureaucracy of senior managers [38]. Finally, in marketing phase, consumers' involvement can lead to an alignment of products with their needs, a company approach to target audience, an increase brand awareness and loyalty, because participants, by word of mouth, bring new customers [38].

2.2 Fragility factors in crowdsourcing

The variety of stakeholders involved is probably the main strength of crowdsourcing: existing consumers but also potential ones, organization's staff interacting beyond internal employee network fighting known mental schemes [16] [17] [33]. The greater speed of response to changes and simplification of learning also foster innovation.

Organizations, thanks to crowdsourcing, have the opportunity to develop continuous learning systems that give them a competitive advantage [33]. Crowdsourcing can contribute to making organizations more flexible and capable to predict market change because crowdsourcing can provide direct access consumers' knowledge - tacit and explicit – thus improving new product development processes [17][33][43]. More generally, digital connection initiatives provide companies with better tools to connect with

upstream suppliers and downstream consumers, to become more flexible, absorb quickly, apply and use existing and new knowledge to their own advantage by facilitating exploitation of knowledge itself [43] and co-creating value.

On the other side, significant organizational changes are often necessary to successfully implement crowdsourcing initiatives, for example by creating decentralized cross-functional teams and boundary-spanning managerial functions. These changes often imply flat decision-making structures, open culture and more collaborative managers [38][40]. The more integrated technology is, the more changes will be needed in organizational culture and structure [38]; it becomes fundamental to manage internal tensions through organizational interventions such as the establishment of teams or intellectual champions essential for reducing inefficiencies [38].

Even when the necessary organizational changes are put in place, crowdsourcing has several potential fragilities, which can be summarized as follows.

1. First of all, crowdsourcing implies relevant information sharing on the part of the *crowdsourcers*, which can raise confidentiality problems and give competitors the opportunity to access relevant information or even ransack ideas and resources [16] [33].
2. Secondly, the *crowdsourcer* will benefit from solutions provided by *crowdsourcees* only if it is able to embed the crowdsourcing processes in its own practices, routines, and processes [33].
3. Thirdly, intellectual property rights must be carefully defined and agreed upon by all actors [33].
4. Furthermore, in many cases, crowdsourcing initiatives do not result in really feasible and successful ideas [15][17], because of the cognitive and language gaps between *crowdsourcers* and *crowdsourcees* [15] [36], or because of the intrinsic difficulties of the selection process.
5. In addition, the build-up of effective communication and collaboration between *crowdsourcers* and c*rowdsourcees* may prove surprisingly difficult and resource-consuming [11].
6. Last but not least, crowdsourcing initiatives may result in negative word of mouth and reputational problems that quickly become difficult to control, like for all social media [10].

3 Research method

Due to the exploratory nature of this study, a qualitative approach was adopted [45]. The authors had the opportunity to investigate a representative case of crowdsourcing, that is, a company that links *crowdsourcers* and *crowdsourcees* in the design sector through an online platform and relating services.

The innovative start-up under analysis, which we will label as the Delta case, is particularly interesting because it has developed original solutions to address all of the fragilities identified by the literature and listed in the previous paragraph. Therefore, this case can be leveraged for conducting an inductive study about how crowdsourcing

platforms address the multifaceted organizational and management challenges facing them.

To investigate this issue, a triangulated data collection process was put in place. Two authors collected five interviews with the Delta founder and team. The Delta web site and the platform were analyzed in-depth. One of the authors conducted three participant observations of Delta activities (twelve hours overall), including interactions with customers (crowdsourcers). The social media were browsed to collect users' and designers' opinions on the Delta platform and services.

The texts resulting from these data collection activities were manually coded and discussed by the authors in groups of at least two people. The results were inductively generalized [45] to a tentative model of the key strategies that may transform a crowdsourcing platform into a multivocal inscription that effectively links disparate actors.

4 The "Delta" case

Delta was founded in 2011, in the Seed Village of H-Farm, that is the first venture incubator in the world, sited in North-Eastern Italy. Delta's owner is an architect who previously worked in a design firm. He realized that, in the design sector, young people had few opportunities to emerge, while small firms had few opportunities to access fresh talents to innovate. The Delta company was founded to create a bridge between these two complementary needs. Therefore, whilst Delta' customers are the firms that seek for fresh design ideas, the Delta business model is actually based on a double-sided web platform, that serves *crowdsourcer*s, on the one side, and (potential) *crowdsourcees,* on the other side.

Since then, the Delta platform has launched more than 90 design contests; the website has been visited by two million people. The Delta community today includes more than 21,000 designers and 93,000 users. Most participants are young (almost 70% are under 35) and international (only 37% are Italian). Delta activities have resulted in more than 20 products on the market so far. Currently, Delta has an average income of about 400,000 euros per year and 5 team members. Italian customers are over 80%.

Delta is today self-supporting and aims to expand globally, moving away from H-Farm. Delta's team is developing a new platform that leverages the Internet of Things (IoT) to offer further, more advanced services to customers.

4.1 Bridging goals

The Delta platform fosters the creation and participatory development of new products, involving both final consumers and experts, in the fields of industrial design, craftsmanship, and interior design. On one hand, it allows creatives to test their talent, to be noticed by companies, to establish their reputation in the design field, and to compete for remunerated assignments. On the other hand, it allows companies to experiment in new ways to develop and test innovative products.

The promotion and management of value co-creation by diverse and disparate actors are at the core of the Delta business model. The Delta platform, at its core, is an environment for design contests. The contest is the core process that links c*rowdsourcers* and *crowdsourcees*; Delta launches each contest (defining its rules and tools) after a careful analysis of the *crowdsourcer'*s needs and expectations. In addition, Delta provides the c*rowdsourcer* with a structured pre-evaluation of the submitted projects, based on a list of parameters that have been pre-determined with the customer. However, the final choice is up to the *crowdsourcer.*

These contests usually regard product design but may also require the creation of illustrations, interfaces, and graphics. In some cases, the contest is about interior design. The contest can envisage different phases, from broad new concepts to detailed blueprints. *Crowdsourcees* can receive feedback not only from Delta and the *crowdsourcer* that launched the specific contest they participated in but also from the larger Delta community.

A *brief* is a card for designers given by Delta to their companies. It describes the indexed projects by a contest, to develop a new idea, the characteristics of a product, its functionalities, the evaluation parameters, the deadline and, finally, the compensation. When *design research* phase begins, international community generates concepts and ideas according to call and upload them to the site. Once completed, the *social research* starts and provides international online feedback, from both members of Delta community and site visitors.

Furthermore, Delta takes care of *pre-selecting* projects and the customer selects one or more of them, leading to the implementation phase. The winners of the contest receive a cash compensation (usually from 3,000 to 5,000€) and, sometimes, also royalties. Delta allows designers to be noticed and receive feedback from companies and other artists belonging to the community. Co-creation opportunities are strategic options for creating value.

Delta provides several contests to meet different customers' needs: Global option, open to the whole community and external users for a duration of 60 to 90 days; Global Multiphase, in two steps, one for the idea collection and the second for product design; Team option, reserved for acquired customers, involving only selected designers based on their proximity and agreement with the brief and invited by Delta through an access code. This third type does not receive many ideas, due to the limited number of participants, but it can be useful if the company needs an exploratory contest or very detailed proposals in a short time. White Label, finally, is a personalized platform hosted within a subdomain of company's website, whose main advantage is to build a community and keep it linked to the brand rather than to Delta platform, even if the latter deals with the race, the brief definition, and the community management.

Multinationals tend to use Delta services to conduct trend research; conversely, smaller companies lacking an internal R&D department are more interested in being supported in new product development.

Delta does not substitute the traditional approach for new ideas or product development but, managing the value co-creation, tries to help internal processes, avoiding dispersion of energy and resources. Delta, indeed, mitigates this aspect by identifying the interesting idea and to focus on its development, often in collaboration with designers.

Delta users have different skills: designers, engineers, students, artisans, architects. The motivations that encourage participation, typical of crowdsourcing, are e.g. the opportunity to connect with other creatives and with companies, to expand network, to build a portfolio, to be noticed, to test their skills, to receive feedback, to receive a fee, to see their project on the market, but also more simply to be informed about design world. Extrinsic motivations, i.e. cash compensation, possibility of making a career or expanding the network, prevail; there are also intrinsic motivations, such as to get involved and work on a project only for the pleasure of doing it.

The internationality of participants intercepts the specific needs of each country; the same brief is differently read according to culture and background, has differentiated offer for each company, especially if operating in the global market. A product design project can also involve architects or engineers, who usually do not do that kind of work, creating a high level of contamination and presence of various points of view. This would be impossible with a traditional approach that intercepts product study design. Specific competencies for participation in contests vary according to the requests of the brief and there are barriers to entry of knowledge. The request for more or less specific skills means that participants self-select themselves for those projects for which they feel more prepared to make their own contribution; a number of proposals changes a lot between low and high complexity contest (from 5-6 to almost 300). Some winners had a collaboration contract with the company.

4.2 Reconciling preoccupations

Reluctance in sharing information afflicts both medium-small companies and large multinationals, which fear exposure to competitors and do not want to make their ideas public. Companies have often diffidence in sharing their know-how or materials and techniques; in order to overcome diffidence, Delta has several options to guarantee various confidentiality degrees and protection and achieving completely new results. *Public mode*, for example, is an open contest when community vote implements the best projects ranking through social networks; the designer, uploading a project on the platform, indirectly promotes also the brand that launched the contest.

Another example is *contested with non-disclosure agreement*: participants mustn't reveal any details or information about contest and proposals uploaded and this don't encourage participation of creative people, that usually don't like projects before knowing what they have to work on.

The third example is the *contest with private gallery*: only the company can view uploaded proposals, renouncing to a community vote, feedback and comments from registered users.

Finally, *invitational contests*, designed to involve a selected group of participants based on specific features through the assignment of an access code by Delta. Different options respond to various needs, type of contest and product that has to be developed. If the contest aims to search an idea that does not exist on the market, Delta recommends open gallery; however, companies seem to prefer often the option with a private gallery.

The preoccupations of c*rowdsourcees* are completely different, and to some extent frankly conflicting with those of the c*rowdsourcers*. The analysis of social media and

designers' blogs reveals that many professional designers view crowdsourcing platforms as a means of unfair exploitation on the part of *crowdsourcers*. In the design sector, the process of hiring a creative professional has been traditionally based on trustful, personal relationships between designers and companies in need of creative work. According to many designers, crowdsourcing platforms jeopardize this model and these relationships, at the exclusive advantage of companies that want to save money. These designers complain that, according to the Delta rules of the game, those who do not win the contest earn nothing in exchange for their work, whilst even those who win receive very low compensation. Some design professionals even invite their colleagues to boycott Delta (and the other crowdsourcing platforms) in order to safeguard the dignity and economic sustainability of their job.

In the face of these controversies, Delta seeks to reassure the community that their services do not replace the traditional relationships between companies and creative professionals, but rather complements them. The Delta platform highlights that most contests are best suited for non-professionals, students, or very young professionals, who are mainly rewarded through the opportunity of making an experience and building up a reputation. For more challenging, complex design problems, Delta suggests invitational contests, that are better suited to protect the interests of experienced professionals.

5 Discussion and Conclusions

The analysis of the Delta organization reveals that crowdsourcing intermediaries need to bridge the gaps between *crowdsourcers* and c*rowdsourcees* both at the operational and at the strategic level.

At an operational level, Delta strived to build a platform with contents (e.g. texts and images) and procedures (e.g. project submission requirements) that are compatible with the languages, practices and knowledge bases of both *crowdsourcer*s and *crowdsourcee*s, respectively. For example, participants that submit a project are required to use templates and formats they are likely familiar with, on the one side, and that facilitate the comparative evaluation of proposals by the *crowdsourcees*, on the other side. In this light, we can conclude that the effort to build "operational multivocality" has been key to Delta's success in its field.

At a higher level, on the other hand, bridging the gap between the different goals and preoccupations of *crowdsourcer*s and c*rowdsourcees* has proved even more complex than bridging their different languages, practices and knowledge bases. In order to address the differences across goals and preoccupations, a further dimension of multivocality has been developed in the case under analysis. We label this higher-level multivocality as the "strategic multivocality" of the crowdsourcing platform.

Based on the results of this case study, we argue that this strategic multivocality has two main dimensions: bridging goals, and preoccupations. In this light, the Delta platform has to reconcile these different goals of *crowdsourcers* and c*rowdsourcees*, be

they customers or designers, and also has to balance the interests, concerns and logics of the *crowdsourcers*' organizational structure, especially the R&D department.

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AIS in the Time of Blockchain

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Abstract. Distributed Ledger Technology - of which Blockchain is an example - is revolutionizing different sectors, creating new challenges and new opportunities. In this paper, we will investigate the impact of this technology on Accounting and Accounting Information Systems (AIS). The adoption of a Distributed Ledger Accounting presents extremely interesting characteristics, eliminating or redefining the role of entities external to the company, such as Banks, Insurance Companies, Certified Public Accountants and Auditors. Furthermore, we will try to outline the impact of this technology on AIS by hypothesising possible paths of development.

Keywords: Accounting Information Systems, Distributed Ledger Technology, Blockchain, Triple Entry Accounting.

1 Introduction

Distributed Ledger Technology, the so-called Blockchain, is revolutionizing the Internet. On the other hand, the Internet itself is changing, following the requests of those who wish that it became not only a place of information exchange, but also a virtual place to exchange actual values.

In this paper, we will try to understand the interrelations between the Internet of Information, the Internet of Things, the Internet of Values and Blockchain, analyzing firstly the evolution of the Internet and then the Blockchain technology.

We will analyse in depth the Distributed Ledger Technology and its relationships with Accountability and Accounting. We will then analyse the impact of Blockchain on Accounting Systems and finally we will examine the changes to be made to Accounting Information Systems to exploit this technology.

Beyond the emphasis with which many researchers invite to welcome this new technology, we will try to understand if Distributed Ledger Technology really has the ability to revolutionize Accounting and Accounting Information Systems.

Some research questions emerge from this analysis:

RQ1: What is the Blockchain and what are the characteristics that will probably make it widely used?

RQ2: What impact will the adoption of Blockchain technology have on business intermediaries?

RQ3: Will the Blockchain be universally adopted in the AIS of all companies?

RQ4: What could be the development paths of the AISs taking into account the Blockchain Technology?

2 Internet of Information, Internet of Things, Internet of Value

For the last forty years, we have had the Internet of Information. In 1989, Tim Berners-Lee created the World Wide Web. The information-centric medium of the web relies on an interlinked page model and publishing language (HTML), and it is conceived to exchange nothing but information. The Internet has evolved following two main, distinct but complementary directions: the Internet of Things and the Internet of Values.

2.1 The Internet of Things.

The Internet of Things (IOT) concept was coined in 1999 by Kevin Ashton, a member of the Radio Frequency Identification (RFID) development community [2], and it has recently become more relevant to the practical world largely because of the growth of mobile devices, embedded and ubiquitous communication and cloud computing. [22]

Currently, the Internet is not only a network of computers, but it has evolved into a network of device of all type and sizes. Computers, vehicles, smart phones, home appliances, toys, cameras, medical instruments and industrial systems, animals, people, buildings, all connected, all communicating and sharing information. Adopting stipulated protocols these devices achieve smart reorganizations, positioning, tracing, safe and control and even personal real time online monitoring, online upgrade, process control and administration [22].

Imagine a world where billions of objects can sense, communicate and share information, all interconnected over public or private Internet Protocol (IP) networks. These interconnected objects have data regularly collected, analyzed and used to initiate action, providing a wealth of intelligence for planning, management and decision making. This is the world of the Internet of Things (IoT).

IoT is a concept and a paradigm that considers pervasive presence in the environment of a variety of things/objects that through wireless and wired connections and unique addressing schemes are able to interact with each other and cooperate with other things/objects to create new applications/services and reach common goals. In this context, the research and development challenges to create a smart world are enormous. [12]

Taking this a step further and discussing the IoT, an even brighter focus should be on the concepts of co-creation of value. Traditionally, value has been created within a firm with minimal interaction by consumers (except for user tests etc. during the development phase). Firstly the Internet, secondly Web 2.0 and thirdly, and next, the IoT makes it possible to incorporate and interact with customers in any phase of the value creation process. This is a prerequisite for a value centered design process of future products and services. A common view on co-creation is that value is created by collaboration, facilitated by technology (like the Internet), between people. However,

some of the next disruptive moves that might create opportunities are the ideas around the Internet of Things. [18][32]

2.2 The Internet of Value

The Internet was conceived to exchange information; it was not designed to handle the exchange of value. Anyone transferring money online is not actually moving the value directly. Instead, they are sending instructions to an intermediary - whether through a bank or a credit card company - to pass on the value. [29]

No movement of value can be done directly over the Internet but it has to be done via a third-party broker. The involvement of such third parties in the exchange of value: 1) it needs a party that is trusted from both the actors, sender and receiver; 2) it comes at a cost.

> *"The Internet of Information was great but it did have a big weakness. You could not store, move, and transact value without a powerful intermediary. The underlying technology of blockchains might actually represent a second era of the Internet. For the last 40 years we've had the Internet of Information; now, with Blockchains, we're getting the Internet of Value."*[29]

On the Internet, information can be replicated indefinitely without additional costs. This is a problem when it is necessary to transfer a sum of money: money must pass from subject A to subject B without duplication. In other words, we must be sure that after the transaction the amount that is in the portfolio of B is no longer present in the portfolio of A. For this reason, we use an intermediary, such as a bank, and we order to transfer the amount from A to B. Conversely, if we use a virtual currency, such as an amount in Bitcoin, we can transfer the desired amount from the virtual portfolio of A to that of B by recording the transaction on a Distributed Ledger. This is, concisely, the function of Distributed Ledger Technology.

3 Blockchain Definition

Distributed Ledger Technology (DLT) is a technological protocol that enables data to be exchanged directly between different contracting parties within a network without the need for intermediaries. The network participants interact with encrypted identities (anonymously). Each transaction is coded and added to an immutable transaction chain. This chain is distributed to all network nodes (ledgers), thus preventing the alteration of the chain itself. [7] Although the correct denomination of this technology is DLT, we will use the most appealing name of Blockchain in the rest of the paper.

3.1 Blockchain technology in details.

The Blockchain can be seen as the distributed, decentralized, transparent and chronological database of transactions, sometimes also called the Ledger. The data in the

blockchain (e.g transactions) is divided into blocks. Each block is dependent on the previous one. The system in which a blockchain serves as the database comprises of nodes or workers. These workers are responsible for appending new blocks to the blockchain.

A new block can only be appended after all nodes in the system reach a consensus, i.e all agree that this block is legitimate and contains only valid transactions. How the validity of transactions is determined and how the nodes compute new blocks, is regulated by the protocol. Blockchain is shared among all nodes in the system; it is monitored by every node and at the same time controlled by none. The protocol itself is responsible to keep the blockchain valid.

According to the literature [28] there are three main categories of Blockchain applications:

Blockchain 1.0:
Currency - The currency and services associated with money transfers such as payment mechanisms and remittance services. Currently, there are hundreds of different types of cryptocurrencies with bitcoin remaining the biggest by market cup. The currencies may have different features such as being tied to a fiat currency or commodity but their nature stays the same – they are used for payments and transfers of digital property.

Blockchain 2.0:
Smart contracts – it is a layer of smart-contracts, which are more sophisticated than just a currency. A 'smart contract' is a computer protocol intended to digitally facilitate, verify, or enforce the negotiation or performance of a contract. Smart contracts allow the performance of credible transactions without third parties. These transactions are trackable and irreversible. Nick Szabo, who coined the term, in 1994, firstly proposed the adoption of smart contracts. [3]

Smart-contracts can represent shares of stocks, bonds, options, mortgages and smart property. While the 1.0 concept represents decentralization of money, the 2.0 concept is a decentralization of markets. All the technologies aiming at decentralization of relationships of different counterparties such clearing houses, banks, companies are covered by this concept. Some interesting examples are peer-to-peer lending services Btcjam, Bitbond, Crowd-funding platform Koinify, bitcoin prediction markets Augur, Fairlay. A potential accounting system on Blockchain is, therefore, covered by the 2.0 concept as it is supposed to represent a smart-contract system where the transactions and automatically paid bills are executed and recorded. Almost since the introduction of Bitcoin and its underlying blockchain ledger, researchers began to explore other field where a blockchain technology might be of great use. With Blockchain 2.0 we introduce additional types of blockchains and reason about their potential in other fields beyond cryptocurrency. Some of those potential applications are:

- General (bonded contracts, multiple signature transactions)
- Financial transactions (pensions, stocks ...)
- Public records (land titles, vehicle registrations ...)

- Identification (drivers license, ids ...)
- Private records (loans, contracts ...)
- Physical asset keys (home, hotel rooms, rental cars)
- Intangible assets (patents, trademarks, ...)

Blockchain 3.0:
Areas in government, health, science etc. - it is a Blockchain applications system beyond financial markets and covers government, art, culture and science. Examples of 3.0 applications are Blockchain voting systems, Decentralized Domain Name system – Namecoin, anti-censorship applications like Alexandria and Ostel, and many other applications using immutability and transparency properties of blockchain to promote freedom, democracy and fair allocation of wealth.

3.2 Distributed Ledger Technology Features.

An extensive literature illustrates in detail the technical characteristics of the Distributed Ledger Technology [25][28]. DLT, of which Blockchain is an example, uses cryptographic tools and a distributed consensus process to create a significant innovation in traditional record keeping. It has three main features [7]:

- **Veracity** – multiple copies (as opposed to a single copy) of the complete historical record of ledger entries are each verified by consensus. Bogus entries are identified and eliminated by failure to reach consensus.
- **Transparency** – it is a public record of activity that can be seen by all market participants.
- **Disintermediation** – it operates using a peer-to-peer network, rather than requiring a specific central organization.

Disintermediation is the core feature that drives the benefits associated with distributed ledgers. Traditionally, systems that have centralized ledgers have required the participation of a trusted third party to maintain a record of transactions between organizations. A Distributed Ledger overcomes the need for a third party, which can be a significant benefit when there is no clear trusted central organization, or if the costs of intermediation are high. [7]

Main applications of Distributed Ledger Technology so far have been in financial services, namely Bitcoin and all other cryptocurrencies. With Blockchain, we can imagine a world in which contracts are embedded in digital code and stored in transparent, shared databases, where they are protected from deletion, tampering and revision- In this world every agreement, every process, every task and every payment would have a digital record and signature that could be identified, validated, stored and shared. Intermediaries like lawyers, brokers and bankers might no longer be necessary. [4]

To date, however, it has not made a significant impact on the core operations of the banking and payments systems, although many banks, including the Federal Reserve, the Bank of England and the Bank of Canada with its Jasper Project, are carefully assessing the possible implications of this technology. [24][6] Moreover, many financial

institutions are experimenting with broader uses like supply chain tracking and digital identity management. [7]

3.3 Blockchain Applications.

Although the Internet is a great tool to aid every sphere of the modern digital life, it is still highly flawed in terms of the lack of security and privacy, especially when it comes to FinTech and E-commerce. [16] [20] Blockchain, the technology behind cryptocurrency, brought forth a new revolution by providing a mechanism for Peer-to-Peer transactions without the need for any intermediary body such as the existing commercial banks. Blockchain validates all the transactions and preserves a permanent record of them while making sure that any identification related information of the users are kept incognito. Thus all the personal information of the users are sequestered while substantiating all the transactions. This is achieved by reconciling mass collaboration by cumulating all the transactions in a computer code based digital ledger. Thus, by applying Blockchain or similar cryptocurrency techniques, the users neither need to trust each other nor do they need an intermediator; rather the trust is manifested within the decentralized network system itself.

Bitcoin is just an exemplary use of the Blockchain. Blockchain is considered to be a novel revolution in the domain of computing enabling limitless applications such as storing and verifying legal documents including deeds and various certificates, healthcare data, IoT, Cloud and so forth. Tapscott indicated Blockchain to be the "World Wide Ledger", enabling many new applications beyond verifying transactions such as in: smart deeds, decentralized and/or autonomous organizations/ government services etc. [29]

Researchers propose these fields of application [13]:

- **Smart contracts.** As we have seen, a general definition of a smart contract would be a computer program that can automatically execute the terms of a contract. By being self-executing and having property ownership information embedded, they can solve the problems of counterparty trust. Smart contracts are trustless, autonomous, and self-sufficient. Instead of reinventing contractual relationships, smart contracts are making their formation and performance more efficient, cost-effective, and transparent. [10] Blockchain and Smart Contracts can work together to trigger payments when a preprogrammed condition of a contractual agreement is triggered. Smart Contracts are really the killer application of the cryptocurrency world. Using blockchain technology has made it much easier to register, verify and execute them. Moreover, open source companies like Ethereum and Codius are already enabling Smart Contracts using blockchain technology and many companies which operate on bitcoin and blockchain technologies are beginning to support Smart Contracts. [8]
- **Domestic payments.** At a procedural level, the process of inter-bank clearing requires an intricate coordination of resource-intensive steps between banks, clearing houses, and the central bank. These steps are typically not executed at a constant

basis, but rather as a processing cycle that happens several times a day. The outcome of it is that payment can often end up credited one or more days after their initiation, especially over weekends or holidays. The intricacy of the current system constitute a procedural challenge for payment service providers, and highlights the need for a more efficient system for real-time payment, both domestically and internationally.

- **International payments.** To achieve real-time payments on an international scale, there will be a need to introduce foreign exchange (FX) market makers to the blockchain network. They will perform currency conversions on transactions between consumer bank accounts. Central bank participation on the network in a market maker capacity would also be needed between payment service providers in different currency jurisdictions. In this way, real-time payments could potentially be achieved on a cost-effective basis.
- **Trade finance.** Digitization and automation of trade processes has been ongoing for many years, but the banks' updated processes are still largely based around the logistics of handling physical documents. Many processes share similar characteristics, but requires completely different IT systems and procedural steps to manage. An example here would be documentary collection, letter of credit and consignment. All of these processes follow roughly the same five steps: 1) Extension of credit to customer; 2) Informing the customer of credit status; 3) Banks open a communication channel regarding the customer; 4) Updating the status of goods from freight forwarder; 5) Execution of full or partial payment of funds based on certain criteria. Blockchain technology could bring the benefits of automation to these trades. Through the use of cryptographic keys and multisignature wallets, one can create a replacement for traditional trade finance documents, which are stored on the blockchain as a Smart Contract. The document is updated by blockchain transactions as it moves through the steps of the trade process.
- **Capital markets.** When trading on the capital market, there exists a set of procedural steps that enable the trading of assets in a legally conforming fashion, as well as a number of custodian services revolving around facilitating the trade. A broad definition of these steps can be termed as such: 1) Create a representation of an asset, such as a currency, bonds, stocks, gold, etc.; 2) Enable a trade to take place between two or more stakeholders; 3) Balances must be recorded and kept; 4) The eventual liquidation of an investor's position.

4 Blockchain and Accountability

Researchers analyzed the enterprise opportunities for Blockchain-IoT convergence supporting trusted machine identity, interactions, and transactions [15]. Their research finds that, if developed for scale, Blockchain could offer IoT a level of interoperability, transparency, and security currently absent from today's architectures, but essential to ecosystem-driven business models and autonomous products and services. What we need is accountability.

The term "accountability" is described in various ways depending on the domain in which it is used. Internet transaction is increasing significantly due to very fast grown

of mobile devices, electronic commerce, and electronic records, i.e. a very fast grown of IoT.

A general definition incorporating the main elements of accountability is directed to the obligation of a person (the accountable) to another person (the accountee), according to which the former must give account of, explain and justify his actions or decisions in an appropriate way [34]

In electronic commerce, accountability involves access or denial to parties for transactions. Various researchers have proposed protocols to analyze accountability for Internet transactions, particularly payment transactions. [30][31]

Accountability can be framed along the following three elements: [34]

- Standards need to be introduced that hold governing bodies accountable, at least on the organizational level; such standards help to improve accountability;
- Information should be made more readily available to the concerned recipients, enabling them to apply the standards in question to the performance of those who are held to account; in order to make information flow active rather than passive consultation procedures are to be established;
- Beneficiaries of accountability must be able to impose some sort of sanction, thus, attaching costs to the failure to meet the standards; such "sanctioning" is only possible if adequate participation schemes are devised through direct voting channels and indirect representation schemes.

Neisse et al. proposed a solution for data accountability and provenance automatic tracking that relies on a public blockchain-based distributed ledger platform, namely the open source Ethereum Virtual Machine (EVM) [21], while Crabtree et al. suggested the development of accountability based mechanisms provided by an IoT Databox model. This model seeks to respond to the external data subject accountability requirements of actual and proposed legislation in Europe and the US on Personal Data Protection. [9]

5 Blockchain and Accounting

Modern financial accounting is based on a double entry system. Double entry bookkeeping (DEB) revolutionized the field of financial accounting during the Renaissance period. DEB solved the problem of managers knowing whether they could trust their own books. However, to gain the trust of outsiders, independent public auditors also verify the company's financial information. Each audit is a costly exercise, binding the company's accountants for long times. [1]

Blockchain technology may represent the next step for accounting: instead of keeping separate records based on transaction receipts, companies can write their transactions directly into a joint register, creating an interlocking system of enduring accounting records. Since all entries are distributed and cryptographically sealed, falsifying or destroying them to conceal activity is practically impossible.

To explain the notion of Blockchain-based accounting some researchers use the term Triple-Entry Accounting which is described as an enhancement to conventional double

entry accounting where the accounting entries of the involved parties are cryptographically sealed by a third entity (the Blockchain). [14] [19]

Since the Blockchain is immutable to any data amendment it is impossible to falsify or delete the written accounting entries. Notably, the notion of triple-entry accounting was first time described in 2005 by Ian Grigg three years before Blockchain was invented. [14] Ian Grigg described the possibility of using cryptographically protected digital receipt to verify transactions occurred between different counterparts and stored by a third party and showing if any details in the records were changed or deleted. With the advent of Blockchain that processes can become automated, cheap and even more reliable as the need for a third party holding the receipts in a centralized manner is superseded by a decentralized ledger.

Lazanis was first to coherently describe the possibility of Blockchain Accounting by conventional companies. He emphasizes that blockchain eliminates the need for trust in any intermediary such as bank or insurance company if a company voluntarily publishes its transactions on Blockchain. [17]

The companies would benefit in many ways: standardization would allow auditors to verify a large portion of the most important data behind the financial statements automatically. The cost and time necessary to conduct an audit would decline considerably. Auditors could spend freed up time on areas they can add more value, e.g. on very complex transactions or on internal control mechanisms.

It is not necessary to start with a joint register for all accounting-entries. The Blockchain as a source of trust can also be extremely helpful in today's accounting structures. It can be gradually integrated with typical accounting procedures: starting from securing the integrity of records, to completely traceable audit trails. At the end of the road, fully automated audits may be reality. [1] Since companies are implementing Blockchain into their Enterprise Resource Planning (ERP) systems, particularly for tasks such as procurement and supplier management, the accountant's and the auditor's role has just evolved. [33]

Blockchain's transparency gives visibility to all transactions for approved users, and this may decrease auditors' work with sampling and validating transactions. However, this allows auditors more time to focus on controls and investigating anomalies. Meanwhile, opportunities are emerging for CPAs to use Blockchain technology as they expand their assurance services to areas such as cybersecurity and sustainability. Blockchain could enable a real-time, verifiable, and transparent accounting ecosystem. It has the potential to transform current auditing practices, resulting in a more precise and timely automatic assurance system. [11]

6 Blockchain and Accounting Information Systems

As we mentioned before, companies are trying to implement Blockchain into their Enterprise Resource Planning (ERP) systems, particularly for tasks such as procurement and supplier management. Blockchain ledger-based technology can simplify the procurement process because it enables secure recording of transactions in a way that can lead to unprecedented transparency and increased operational efficiency. [33]

6.1 Blockchain as a Service (BaaS)

Claimed benefits of Blockchain include offering business value and efficiency gains by, for example, assisting compliance, asset tracking, supply chain management, and generally displacing intermediaries. The focus is particularly on multi-party scenarios (across organizations, departments, individuals, etc.), where the ledger provides a transparent and reliable source of facts across administrative domains. [27]

As such, "Blockchain-as-a-Service" (BaaS) offerings are emerging to make Blockchain more accessible to businesses, by reducing the overheads of adoption. BaaS entails a service provider offering and managing various components of a Blockchain infrastructure. The precise nature of a BaaS deployment depends on the service provider, application specifics, and the customer goals. Several IT solution companies provide BaaS solutions, see Tab. 1 [23]

Table 1. Top 10 Blockchain as a Service Providers [23]

Provider	Partners	Tool name	Crypto-value
Microsoft	Microsoft, ConsenSys, Blockstack Labs	Azure	Ethereum
R3	Barclays, Credit Suisse, Goldman Sachs, J.P. Morgan, and Royal Bank of Scotland, and more than 70 partners, including Bank of America and Wells Fargo.	Corda	
HPE R3	HPE	Corda	
SAP Cloud Platform Blockchain	SAP	Leonardo	
BitSE	BitSE, PricewaterhouseCoopers (PwC)	VeChain	
Blocko	Blocko, Samsung, LG CNS, Hyundai, other South Korean firms	Coinstack	Lotte card
Blockstream	Blockstream	Lightning Charge, Lightning Network	Bitcoin
PayStand	PayStand		
Peer Ledger	Peer Ledger		
Deloitte	Deloitte	Rubix Core	Ethereum

6.2 Real-time Blockchain Accounting System

Real-time Blockchain Accounting System (RBAS) is a software solution that enables transactions of currency, financial derivatives, and other digital documents between two or more counterparts, stores the transaction data in cryptographically protected blocks whose integrity is verified through the process of mining, and allows the composition of financial statements at any time. [24]

For companies and their stakeholder to obtain all the benefits provided by the technology it is necessary that a RBAS possesses the following properties:

1. Transparency - the transactions must visible in real-time as it is the case with bitcoin
2. Immutability - there must not be a programming possibility to change any data once they were entered, to ensure this, the company using the system must not control the mining power.
3. Accessibility – the data must be easily accessible to a broad range of stakeholders.

Financial statements are prepared at regular intervals and sum up what has happened in a firm's ledger throughout a certain period. An auditor then issues an opinion on the accuracy of the financial statements. Outsiders, such as investors and credit risk managers, have to trust both that the auditing is thorough and unbiased and that the firm has not given false information to the auditor. That is, the concept of trust is critical in both the preparation of the financial statement and in the auditing process.
This is where the Blockchain technology behind the bitcoin can play an integral role. [5] If a firm were to voluntarily post all of its business transactions on a blockchain, with a permanent time stamp on each transaction, the firm's entire ledger would be instantaneously visible and anyone could aggregate the firm's transactions into income statements and balance sheets in real-time. That is, many of the things the auditor does in today's accounting world, the blockchain can possibly do much more efficiently and much more timely in tomorrow's. By construction, if a firm kept all its transactions and balances on a blockchain, then the blockchain itself could, largely, replace the auditor in confirming the accuracy of the firm's accounting, thus avoiding potential moral hazard or agency problems. [5]

6.3 The adoption of Blockchain in AISs

Although there is a noteworthy academic literature about the Blockchain, its applications and the benefits that can be achieved with its adoption, there are no works related to real applications in AIS systems, as far as we know.

Many "big players" like Microsoft, SAP or Deloitte are starting to offer solutions that incorporate Blokchain-related technologies, typically based on a "Blockchain As A Service" approach as those that we have seen. However, these solutions are still at a prototype stage and the related documentation is halfway between a declaration of intent and a marketing proposal.

Another aspect ignored by the current literature concerns the evolution of ERP systems in a Blockchain perspective. Adopting DLT in an ERP system means intervening heavily on the main modules of the systems, modifying in depth modules such as Financial Accounting (FI), Asset Accounting (AA), Sales & Distribution (SD) and Material Management (MM), using SAP terminology. For this reason, we believe unlikely to see in the future new versions of existing ERP systems that effectively include Blockchain features.

Conversely, a company that wants to implement Blockchain-based solutions is much more likely to use a platform like the one offered by the above-mentioned BaaS systems.

6.4 Pros and cons of the Blockchain

The above-mentioned literature highlights characteristics, merits and advantages deriving from the adoption of DLT systems. However, no paper highlights the point of view of companies. What are the actual costs of implementing DLT systems? What are the real – not theoretical - advantages for the company deriving from the adoption of such systems?

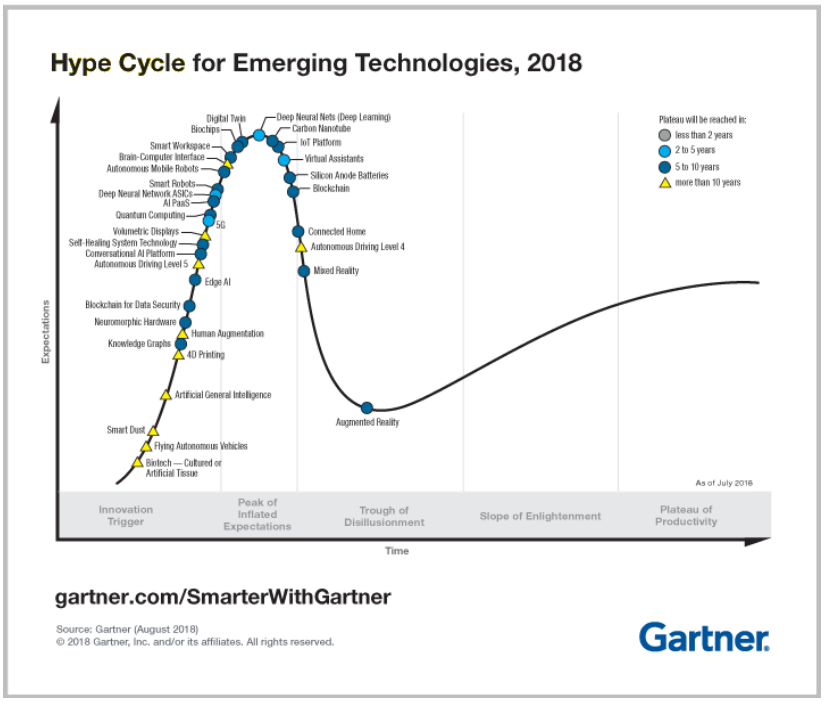

Fig. 1. Hype Cycle for Emerging Technologies, 2018 [35].

In current literature, some fundamental aspects are left out. The evidences are that adoption of DLT-based systems only makes sense if:

1) all or most of the members of the Value Chain adopt these systems;
2) the costs of new disintermediation services are lower than the costs of current service providers;
3) it is possible to adopt cryptocurrencies in order to take full advantage of the benefits offered by the Internet of Values.

This is not the case, as an example, for Small and Medium Enterprises (SME) or large companies that sell to thousands of end consumers, such as Amazon. In small

companies there is no obligation to audit, so the benefits of such complex accounting are lost.

As often happens in the field of IT, after an initial emphasis on the theoretical advantages of an innovation that feed great expectations, we are heading towards a phase of disappointment of these expectations (see Fig. 1) [35].

In this sense, the only voice out of the chorus is Rückeshäuser. While agreeing with the adoption of a Blockchain Accounting, she believes that it alone is not sufficient to eliminate accounting fraud [26]

7 Conclusions

Internet has changed: from the Internet of Information it has become Internet of Values. Blockchain is certainly one of the technologies that led to this transformation.

In conclusion, we can answer the Research Questions that we had placed in the introduction:

RQ1: What is the Blockchain and what are the characteristics that will probably make it widely used?
Distributed Ledger Technology (DLT), of which Blockchain is an example, is a technological protocol that enables data to be exchanged directly between different contracting parties within a network without the need for intermediaries. Blockchain uses cryptographic tools and a distributed consensus process to create a significant innovation in traditional record keeping.

RQ2: What impact will the adoption of Blockchain technology have on business intermediaries?
Disintermediation is the core feature that drives the benefits associated with Distributed Ledgers. Traditionally, systems that have centralized ledgers have required the participation of a trusted third party to maintain a record of transactions between organizations. A Distributed Ledger overcomes the need for a third party, which can be a significant benefit when there is no clear trusted central organization, or if the costs of intermediation are high. Intermediaries such as banks, insurance companies and auditors will have to redefine their relationships with companies.

RQ3: Will the Blockchain be universally adopted in the AIS of all companies?
The adoption of DLT-based systems only makes sense if: 1) all or most of the members of the Value Chain adopt these systems; 2) the costs of new disintermediation services are lower than the costs of current service providers; 3) it is possible to adopt cryptocurrencies in order to take full advantage of the benefits offered by the Internet of Values. This is not the case, as an example, for Small and Medium Enterprises (SME) or large companies that sell to thousands of end consumers, such as Amazon.

RQ4: What could be the development paths of the AISs taking into account the Blockchain Technology?

Adopting DLT in an ERP system means intervening heavily on the main modules of ERP systems. For this reason, we believe unlikely to see in the future new versions of existing ERP systems that effectively include Blockchain features. Conversely, a company that wants to implement Blockchain-based solutions is much more likely to use a platform as the one offered by "Blockchain as a System" (BaaS) systems.

In conclusion, we can state that the Blockchain technology is extremely interesting and its adoption has great theoretical advantages. However, we will have to evaluate the implications and the costs of its use. Moreover, it remains to be seen what will be the steps to be followed for its introduction, especially considering that at present there are no studies that analyse these processes.

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