Community Clouds for Societal Intelligence: The Labour Market Case-Study

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***Abstract*—The onset of electronic markets, cloud computing, and high-edge digital ecosystems created many cultural, economic, anthropological shifts in our society, labour and skills localization and retrieval being among the most critical. However, Cloud computing and Big Data analytics now offer the potential to make the act of finding the right skills into a *business intelligence* problem, which we can formulate and support with specific *community clouds*, that is, cloud architecture models which blend administrative and technical partners in cooperation for a smarter society. We propose one such community cloud focusing on the labour market. This market has seen several attempts at devising such community clouds in the past (e.g., the Visier CloudBase[1]) but these attempts emerged as either expensive, unpractical, too generic or ad-hoc. This article outlines and discusses the design of a community cloud for geolocalised *labour intelligence*, intended as the ability of societal administrators to apply Big Data analytics and elicit business intelligence over geolocalised big data describing all elements and actors in the labour market, be it at the supply or demand side. We illustrate our design proposal with a real-life case-study.**

I. Introduction

One of the major downsides of our digital economy is the increasing predominance with which technology has substituted human labour and skills. On one hand, computing skills are increasing in demand and low in supply. On the other hand, formerly needed skills and labour areas often become subject to crisis. The EU recognized this shortcoming with several reports [1], [2]. For example, According to the European Political Strategy Center (EPSC)[2] indicates that the Gig Economy, wherefore teams of freelancers of compounding abilities assemble, execute, and deliver projects and products "on-the-fly, is becoming the norm, rather than the exception. Similarly, the report of the International Labour Association[3] states that crowdwork and freelancing is a growing sector that is continuously victim of unfair waging, abusive contracting, non-inclusive, diminishing and/or underemployment conditions largely ignored by online mediator platforms (e.g., Amazon MTurk , Crowdflower...) currently available, which, in turn, prey on contractual agreements and thrive over unequal distribution of wealth. On one hand, Self-employment in the EU constitutes 16.4 percent of the labor market; on the other hand, freelancers have been on the rise steadily since the early 2000s. On the other hand, there is a lack of cohesive technologies and digital platforms to sustain their work in a fair fashion, ensuring mutual understanding and fair wage to maximize collaboration yields.

This rise of independent and alternative working arrangements are strongly perceived at all levels and across all EU countries and will result in skills-shortage if not correctly supported, quoting from the EPSC report: "the most productive firms, the so-called frontier firms, as well as the younger gazelles (rapidly growing firms) are seeking high-skilled and digitally-savvy workers [...] particular concern for Europe is the projected skills shortage is forecast to 825,000 unfilled vacancies by 2020. What is more, critical sectors of the knowledge economy in the EU are developing phenomena such as Digital Nomadism, that is, freelance professional workforce travelling from location to location, from project to project, without committing to any single organization; these phenomena are spiraling out of control, rather than becoming a business opportunity.

We argue that the above are **societal** shortcomings and reflect just one example of the relative lack of *societal intelligence*, that is, the ability of our society to harness the digital ecosystem and turn it into an opportunity for garnering societal business intelligence.

From the above premises, this article outlines a design for community clouds [3], [4] specifically engineered to provide intelligence in the labour market, sustaining it as the ecosystem it became since the onset of the digital revolution. We argue that in such an ecosystem, the demand-offer meet-up must be transformed into a business intelligence activity where ecosystem participants (jobseekers, employers, mediators, trainers, authorities,...) all join in a federated machine-learning [5] exercise for the purposes of: (a) geolocalizing available skills and employment options; (b) allowing targeted refinement of skills in low-compliance areas (e.g., borderlands or locations far from requalification institutes and universities); (c) identifying bottlenecks to be addressed at the societal level (e.g., overly restrictive control policies in cross-border areas).

Illustrating our design proposal over a case-study, we conclude that it shows great potential in fostering societal improvement using a community-based, technologically-supported approach.

The rest of this paper is arranged as follows. Section II

[1] https://www.visier.com/

[2] http://www.skillsforemployment.org/KSP/en/Details/?dn=WCMSTEST4_176856

[3] http://www.ilo.org/wcmsp5/groups/public/---ed_protect/---protrav/---travail/documents/publication/wcms_479693.pdf

outlines the state of the art. section III outlines our community cloud design proposal. Sections IV and V discuss and conclude our paper.

II. State of the Art

A. Labour-Support Services

There are several examples of services and cloud applications to support the labour market operations. Typical examples of such services are crowdsourcing portals such as Amazon MTurk[4], Crowdflower[5]. Similarly, many closed-source cloud applications known as *workforce analytics* platforms exist to support the definition of labour segments, the matching of labour demands (often defined as sets of available skills and experience level), and the representation of labour offer (defined as a set of required skills and experience levels). Among the most prominent examples of such platforms are Visier[6], PeopleFluent[7] and more.

The limitations of these platforms is that they allow analytics focused on the requirements at the demand-side (i.e., companies and organisations seeking to fulfill their labour demands) and do not encompass other key actors such as societal administrators, mediator & educator institutions, and more. These shortcomings make the above platforms from the state of the art rather limited in terms of their ability to effectively represent and sustain the operations of the labour market at large.

In the scope of this article we propose the inception of a community cloud, that is, a federated cloud computing platform where big open data from all actors across the societal target (the labour market, in our case) is retrieved and analyzed for the benefit of all participants. For example, a jobseeker shall be allowed to see which vacancies are available also across the borders of his/her own country, so that he/she can see where jobs are or with which (additional) education his/her chances to enter the labor market can be increased. In turn, employers can use the community cloud to see where the workforce is available. In addition, labor mediators, trainers as well as local, regional, and national authorities can see where opportunities lie or bottlenecks are.

B. Societal Intelligence

We call societal intelligence the family of approaches, services, and platforms that adopt big data analytics, machine-learning or other technologies specific to business intelligence over social, organisational, and societal data for the purpose of a more instrumented, self-sustainable society.

Thus defined, only a handful of such societal intelligence approaches exist. For example, Ramos et al. use Social cognitive maps [6], [7] to instrument swarm intelligence — in this instance societal intelligence is used as a design basis for distributed systems management and artificial intelligence.

[4]http://mturk.com/

[5]https://www.crowdflower.com/

[6]https://www.visier.com/

[7]http://www.peoplefluent.com/products/workforce-analytics

Conversely, many have tried to define the strengths and limitations of considering the use of business intelligence for sustainable societal planning and governance. For example, Iantovics et al. [8] discuss the very notion of societal intelligence, highlighting how extremely intelligent machines may be able to run our society better than ourselves. The design proposal of a community cloud addressed in this article goes in this direction. We seek to instantiate an intelligent system similar to the ones discussed by Iantovics et al., harnessing societal intelligence for the benefit of a more sustainable labour market where demand and offer are met using society-level business intelligence analytics.

C. Community Clouds

Stemming from the National Institute of Standards and Technologies (NIST), The notion of community cloud is defined as follows: "a collaborative effort in which infrastructure is shared between several organizations from a specific community with common concerns [...], whether managed internally or by a third-party and hosted internally or externally. This is controlled and used by a group of organizations that have shared interest. The costs are spread over fewer users than a public cloud (but more than a private cloud), so only some of the cost savings potential of cloud computing are realized". From this definition, few have attempted to generate a reference architecture or have actually addressed the societal goals hidden behind the community cloud notion.

Briscoe et al. [3] define challenges, pitfalls, and technical guidelines for defining and addressing the notion of community clouds but the state of the art is rather poor in terms of research in this direction. We seek to enrich that state of the art with models and technical architectures to support a key societal challenge, that of labour market sustainability.

In the scope of this paper we make a first step in this direction by defining a tentative software design, discussing its strengths and limitations to address them with future work.

III. Designing for Labour Intelligence

- here we use the contents of the proposal to outline challenges and tentative requirements
- we then propose a cloud architecture precisely mimicking what is contained in the proposal
- we identify actors/stakeholders, their concerns and the technical challenges and potential technical solutions we could combine
- we need to discuss the blends of technologies that will be included in the community cloud (open-data, federated machine learing, etc.)

Designing a community cloud for societal intelligence over the labour market entails supporting the operations of 5 essential stakeholders:

- **Citizenship.** Job seekers need to gain access to two essential information: (a) available jobs with precise and clear-cut definition of required job profile, location, expectations, experience, skills, level, and more; (b) lacking expertise per area. Item (a) is needed for job seekers

to weigh their own professional profile against the requirements of the market, whereas item (b) is needed to understand what expertise might the job seeker gain or pursue to enrich his/her own *personal brand* [9] and make it more competitive for the market. In turn, citizens can make available their own personal brand data such that, for example, an instrumented dashboard can process, aggregate, and represent such data for educational institutions which can re-design their educational offer to focus on lacking skills and work on improving their skill level yield.

- **Educator Institutions.** Educators and their institutions need to be provided with knowledge over their strengths and limitations with respect to the demands of the market such that an improved educational offer and agenda may be provided. In turn, educational institutions can make available their own educational performance data over all skills for which they offer training, such that, for example, an instrumented dashboard can use such data to provide citizens with intelligence over what skill is needed where and in which institution can skill levels be improved.
- **Potential Employers.** Employers need to gain access to information and statistics over the available workforce and skills to weigh their requirements of human capital against the combined market offer. In turn, employers can make available data over their projects and skill requirements such that, for example, citizens can decide whether to re-brand their own expertise and labour profile using the skills demand as a starting point.
- **Mediators & Facilitators.** Labour facilitators already provide databases and access points for labour demand and offer. However, their services are limited in providing statistics and predictive analytics over what skill will be needed where, e.g., connected to economical growth or fluctuation, country economy base or similar quantitative/qualitative variables. On one hand, mediators and facilitators should make their own data available, on the other hand, they would benefit from a more granular access to society-wide information. More in particular, mediators and labour facilitators could work for a more inclusive society [10], [11] rather than limiting their operation to helping opt-in citizens in search of a job.
- **Societal Administration.** Societal administration needs to be provided with data concerning all of the above stakeholders with the goal of finding and addressing societal bottlenecks, e.g., difficult or impeding cross-border controls inhibiting traffic.

A general overview of the community cloud stemming from the inter-operation of the above stakeholders is depicted in Fig. 1. The figure outlines a distributed data-store shared among all organisations involved in the labour intelligence scenario (education, employers, etc.). Also, the figure highlights the two technical enables which, to the best of our knowledge, are still absent or lacking from the state of the art, namely:

1) *Smart Cloud Orchestrator.* This component enables and orchestrates the federated operation of multiple private, public, and hybrid clouds following the specific governance protocol defined for the community cloud it is designed to support, i.e., the labour intelligence community cloud, in our case. The Smart Cloud Orchestrator is technically an *orchestrator of orchestrators* since it shall enable the seamless interoperation of multiple service domains operating across multiple authority domains, data domains, and governance domains, for which standard orchestration technologies such as TOSCA-enabled orchestration [12], [13] as well as the recently emerging seamless multi-cloud interoperation technologies must be considered [14], [15], [16].
2) *Societal Analytics Dashboard.* This component enables the analysis and recommendation of societal phenomena (labour intelligence, in our case) for a better instrumentation, control, or mitigation of the phenomena in question.

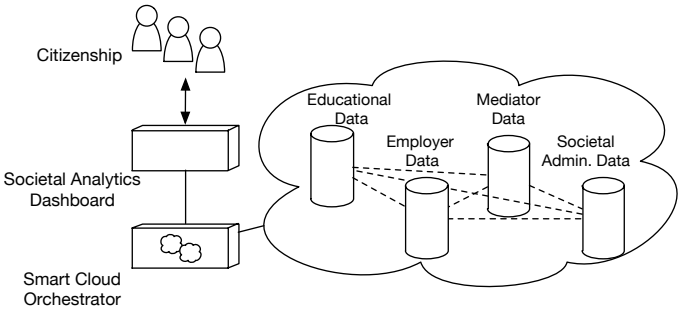

Fig. 1. A Community Cloud for Labour Intelligence.

On one hand, the figure represents a community cloud, since it includes societal public and private parties collaborating for improved societal intelligence.

On the other hand, the figure shows the two major technical limitations emerging from our preliminary design analysis, that is, the lack of a *societal analytics platform* as well as a *smart orchestrator* (see. Fig. 2) capable of effectively managing the multi-cloud environment required by a community cloud for societal intelligence as well as processing geolocalised data over the societal parties in our scenario, presenting the processed/analysed data to everyone in an actionable fashion (e.g., through open-data APIs). On one hand, as previously stated, there exists orchestration technology from which we can inherit and extend for our design purposes. On the other hand, the next section focuses on the requirements and technical baselines behind the above-mentioned societal analytics platform.

A. An Analytical Model for Labour Intelligence

Societal analytics require the definition of a metrics model for needed measurable quantities as well as analyses over those measurable quantities; we call this an *analytical model*. In the scope of this paper we define an analytical model for labour intelligence, comprised of the following measurable quantities:

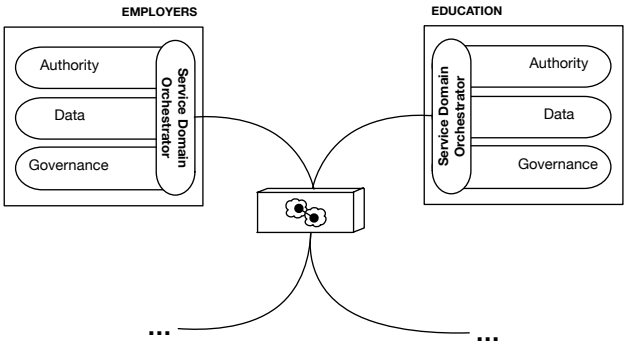

Fig. 2. A Smart Orchestrator System for Labour Intelligence.

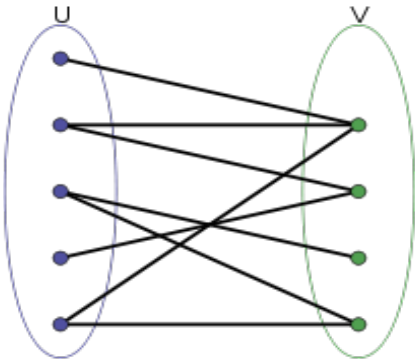

Fig. 3. Expertise Overlap - a bipartite graph of people (U) and expertise areas (V) can be projected (operator "->") by multiplying it by its transposed equivalent (U') - UxU' is a new matrix ("people" x "people") where each cell contains expertise overlaps.

1) [*Required* || *Provided*] *Skill.* A list of skills that are necessary for a certain job-offer to be fulfilled or provided by a specific job-seeker profile.
2) [*Required* || *Provided*] *Skill-Level.* Employers need to be able to express (or infer through analysis) their required skill-levels; similarly, job-seekers require to express their skills and skill-level. In both cases, a standard Likert-like [17] notation can be used.
3) *Cognitive-Distance.* This quantity identifies the algebraical distance between a job-seeker profile (set of skills with respective skill-level) and a required skill-set entailing a job-offer. Cognitive distance has been studied in social-networks analysis and organisations research [18], [19]. To evaluate cognitive distance the state of the art proposes the use of expertise-overlap matrices [20], defined as direct projection, matrix transposition, and multiplication to compute overlap in expertise at the dyadic level [21] – that is, overlaps between the expertise of pairs of individuals or profiles – these overlaps are strongly predictive of profile consistency [22]. Figure 3 outlines the conceptual overview of the expertise overlap matrices previously defined.

The above quantities can be tracked for all the people and required persona's involved in the societal intelligence platform (e.g., all the people in a municipality participating in the platform can have their statistics indexed, tracked, and analysed). In turn, the following analyses shall be carried out:

1) *Skills-Based Regression Modelling.* A specific analysis needs to plot the likelihood that a skill will diminsh or grow under-required in the immediate future, cross-referenced with all available parameters (e.g., geolocation, market segment, etc.); the analysis shall provide a timeframe and confidence of the prediction.
2) *Level-Based Skills Regression Modelling.* A specific analysis needs to plot the likelihood that a certain skill-level will be required in the future based on available data; the analysis shall provide a timeframe and confidence of the prediction.
3) *Deep-Learning for Group Formation.* In substitution of a specific profile, a specific analysis needs to plot the best-fit group of individuals who may jointly be able to satisfy the required persona's. A deep learner is more apt to this task since groups are complex types of organisational structures and feature non-trivial organisational characteristics that may need hierarchically-complex feature detection.

B. Business Requirements

The analytical model defined previously in Sec. III-A offers at least three technical challenges, namely: (a) community cloud ontology harmonization; (b) Big Data governance; (c) Big Data analysis, and synthesis. Following these high-level technical challenges, we defined the 13 business requirements outlined in Tab. I, where column 1 contains a requirement ID, column 2 a name for the business requirement, column 3 the category as above, while finally column 4 contains a brief description of the requirement itself.

C. Technical Baselines

Several technical baselines already exist that can provide a basis for building and maintaining a community cloud for labour intelligence. We identified at least the following.

eXo-Platform. eXo-Platform[8] is a top open-source social-collaboration software. Its features range from user-profiling, secure interfacing with most IDEs and ICT Application Lifecycle Management tools ? The platform is extremely specific to ICT and requires massive adaptation to the context at hand.

Deltek CostPoint. Deltek[9] is a state of the art tool with features for project /product development and management, accounting, labor, reporting and compliance features. Its shortcomings are with respect to social intelligence, social profile, and information tracking, analytics and visualization/synthesis of intelligence, as well as security, safety, fairness, and other non-functional features of the community cloud transactions.

R, RStudio, Apache SparkR. RStudio is a free and open-source integrated development environment (IDE) for R, a programming language for statistical computing and graphics.

[8]https://en.wikipedia.org/wiki/EXo_Platform
[9]http://www.capterra.com/p/155685/Deltek-Costpoint/

TABLE I
BUSINESS REQUIREMENTS FOR LABOUR INTELLIGENCE, AN OVERVIEW.

ID	Name	Category	Description
1	Alignment	Ontology	The community cloud shall provide an underlying ontology which is *aligned* with the desirable features, properties, and definitions of all parties involved, regardless of the partner status, degree of social presence or action.
2	Co-Evolution	Ontology	The community cloud shall provide an underlying ontology which co-evolves together with the evolution of *all* the profiles it is designed to support. Appropriate analyses will need to be put in place to allow ontology and community cloud co-evolution.
3	Privacy	Ontology	The community cloud shall provide profile, type, and/or persona-specific mechanisms to hide, withold, or otherwise obscure any detail concerning the profile, type, and/or persona. Said mechanisms are to be designed with analyses of the likelyhood that the information will be needed for analysis.
4	Openness	Ontology	All the information defined as part of the community cloud shall be open by default and supported in a manner which is consistent with the Linked Open Data schema [23].
5	Participation	Ontology	The ontology underlying the community cloud shall encompass a participatory system for its evolution and further extension. Said participatory system shall enable seamless interoperation with further community clouds.
6	Safety	Governance	The community cloud shall provide mechanisms to warrant for the safe traffic of information across the cloud infrastructure.
7	Privacy	Governance	The community cloud shall provide for all variable and desired privacy levels for all profiles and roles envisioned and supported. The privacy policies shall hold in a private-by-design fashion.
8	Repudiation	Governance	The community cloud shall provide a mechanism to rank and repudiate employers as much as job-seekers to allow for a weighted reputation schema to be built in a personal-branding fashion.
9	Kill-Switching	Governance	The community cloud shall provide opt-out kill-switching wherefore all information pertaining to any party in the cloud, job-seeker or otherwise, may permanently erase any trace of his/her own information, their statistics, any stack-traces of the analyses where that information was previously present and any connected information artefact (logs, etc.).
11	Time-boundedness	A&S	The community cloud shall provide for time-bound and time-seried analyses over all profile-descriptive features and characteristics.
12	Continuity	A&S	The community cloud shall allow for technical, social, and organisational continuity across all community cloud members. Technical continuity entails the seamless integration of systems involved with the community cloud from every authority domain to every other. Social continuity entails the ability to seamlessly reach any socially active party in the cloud. Organisational continuity entails the formation of federated constellations of organisations under the same authority, or governance domain.
13	Shareability	A&S	The community cloud shall allow the shareability of any information contained, stored, or specified in the scope of its supporting infrastructure (i.e., its smart orchestrator). In this respect, the community cloud is to be represented and supported as an enterprise social network [24].
14	Optionality	A&S	The community cloud shall allow any role to select as optional any analysis, definition, datum, sharing or other feature specified and supported in the scope of its infrastructure.

R and RStudio[10] also feature industrial-strength distributed computing (Apache SparkR[11]) that can support the efficient execution of the large-scale social-network analytics, Machine- and Deep-Learning exercises required in the scope of our design specifications.

IV. CASE-STUDY

the case-study in question exemplifies the applicability and potential impact of the design proposed in this manuscript. Our case-study features the economy and the labor market in Dutch border regions which are are less well functioning than in other regions in the Netherlands. This manifests itself in, among other things, relatively low labor force participation and higher unemployment. At the same time, there are opportunities on the other side of the border that are not or insufficiently utilized. Many factors can impede cross-border work. The literature distinguishes between a number of categories: differences in language and culture, institutional and administrative differences, lack of cross-border infrastructure, psychological factors, economic differences and information delays (source: CPB, 2016).

[10]https://en.wikipedia.org/wiki/RStudio

[11]http://spark.apache.org/docs/latest/sparkr.html

In order to meet these barriers to cross-border work, numerous initiatives have been taken over the past decades, particularly in the field of information provision, cross-border job boards and cross-border mediation (source: CPB, 2016):

- In several Euroregions (initially with especially at the German-Dutch border) Border Information Points (GIPs) have been set up to improve the information provision to frontier workers. The Dutch government also contributes to this via the website grensinfo.nl. In mid-2016, the Interreg project 'Grensinfovoorziening Vlaanderen-Nederland' was started, in order to structurally organize the border information facility at the Flemish-Dutch border.
- Cross-border job boards are available from different organizations. For example, the UWV and VDAB publish vacancies from both sides of the border. The GIPs of the D-NL Euregio's have launched the job search site Euregio-Jobroboter, which translates vacancies from German into Dutch and vice versa (source: VNG, 2015).
- Finally, there is EURES, a network of more than 850 advisers, in which all vacancies offered by public national mediation agencies are combined (source: VNG, 2015).

the expected benefits of using a societal intelligence com-

munity cloud in this context would bring about several key benefits, for example: (a) promoting the transparency of the labor market in the VL-NL border region through an innovative approach to data collection; (b) harmonization and visualization via tailored dashboards for the various stakeholders and target groups involved; (c) surgically-precise job-offer/job-demand matching.

Also, implementing the community cloud in question may benefit from the previous baselines and previous initiatives along the lines of labour enablement. For example, inclusion in the community cloud can be envisioned of, inter alia, Eures, that is, the border information points at the VL-NL border.

V. Conclusions

This article outlines the design for a community cloud including an intelligence analytics platform to support a more sustainable labour market. The proposed platform falls into the architecture landscape [25] of what we defined as societal intelligence, that is, the ability of society to become reflective, using big open data analytics to instrument that reflection. Our proposed design was exercised against a real-life case-study from the Dutch borderlands labour acceleration initiative. We observed that several technical challenges exist in our proposed design that deserve further attention. Conversely, we also highlighted the potential impact behind our proposed design and how it may actually instrument societal intelligence in the Netherlands - an impact that can potentially increase the NL national wealth by up to 5% (projected).

In the future we plan to: (a) refine the social, organizational, and technical requirements behind the proposed design; (b) gather hard data over the data-areas present in our case-study to evaluate a potential implementation of a proof-of-concept for our design proposal; (c) elaborate on a possible implementation and evaluation plan of a full-fledged research solution.

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