iVOLUNTEER — A Digital Ecosystem for Life-long Volunteering*

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ABSTRACT

Volunteering is an indispensable cornerstone of our society, covering nearly every part of our life, from social care to emergency management and education. This omnipresence of volunteering led to a plethora of volunteer management systems (VMS), mainly supporting NPOs in scheduling and allocating tasks to volunteers. In contrast to this NPO-centric approach of existing VMS, we focus on volunteers by investigating the following core question: "How can the engagement of volunteers be digitized and exploited in a life-long way". To provide a first step towards answering this question, the contribution of this paper is threefold. First, an in-depth study of related approaches is provided identifying shortcomings but also promising concepts. Second, challenges which have to be tackled to deal with the broad spectrum and peculiarities of volunteering are identified and a vision for a next-generation VMS called iVOLUNTEER is pointed out. Third, promising technologies are identified and discussed in detail to lay the basis for the technical architecture of our envisioned iVOLUNTEER-prototype.

CCS CONCEPTS

• **Information systems** → *Collaborative and social computing systems and tools*;

KEYWORDS

Volunteer Management, Blockchain-Technology, NoSQL-DB, Gamification, Semantic Technologies, Recommender Systems

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1 INTRODUCTION

Indispensable and Omnipresent Volunteering. In times of refugee and health-care crisis, volunteering is becoming more and more an indispensable cornerstone of our society, covering nearly every part of our life, from social care and emergency management to education, sports, politics, religion, environment and cultural activities. More than 10% of the world's population is already volunteering, topped by 23% in the EU, 25% in the US, 36% in Australia and even more than 46% in Austria [50].

Fundamental Changes in Volunteering. The current worldwide growth of both, volunteering demand and supply is intertwined with a fundamental structural change in the whole volunteering sector. While in the past, formal and long-term volunteering organized by NPOs was prevalent, an enormous variety of new forms of volunteering emerged recently, often *informal*, i.e., organization-independent, and *virtual*, i.e., done by digital natives. The spectrum of this new volunteering generation stretches from (i) *Patchwork Volunteers*, being engaged in different NPOs (e.g., from pathfinders to senior-citizens neighbourhood-assistance) during different phases of life, to (ii) *Engagement Hoppers*, getting active in an ad-hoc way depending on own availability and actual demand (e.g., refugee aid or disaster relief), and finally to (iii) *Crowd Volunteers*, performing online *micro tasks* (e.g., postings in online-forums or open-source development). In several countries such as in Austria, these new forms of mostly informal volunteering have even exceeded the amount of formal volunteering [46].

Insufficient IT-Support. As emphasized in the "UN Worlds Volunteerism Report 2015" [50], in face of these current massive developments in volunteering, adequate IT-support for the consequent exploitation of the potential of volunteering is not only of paramount importance from an economic point of view, but lies also in the very own interest of NPOs, help seekers and volunteers themselves. However, current approaches rarely consider the specific interests of a volunteer but focus on the NPOs only.

Aim and Structure of this Paper. Consequently, this paper is trying to approach the challenges induced by the current developments in the volunteering sector from a different point of view. The

Table 1: Comparison of Existing VMS

		iVolunteer FOOTPRINT		iVolunteer MARKETPLACE		iVolunteer ENCOURAGEMENT	
		Trust	Competency Derivation	Recommendation	Brokerage	Incentives	Evolution
Organisation CENTERED	**Movements** movements.org	×	×	×	n.a.	×	×
	BeWorthwhile beworthwhile.me	×	×	✓ semantic matching (competencies, location, time)	×	×	×
	Samaritan samaritan.com	×	~ reviews	✓ semantic matching	×	×	×
	Volgistics volgistics.com	×	×	~ syntactic filtering	×	~ awards	×
	Volunteer Impact betterimpact.com	×	×	~ syntactic filtering	×	×	×
	VolunteerHub volunteerhub.com	×	~ reminder for outdated profiles	×	n.a.	×	×
	VolunteerMatch volunteermatch.org	×	×	~ syntactic filtering (location, keyword)	×	×	×
	Volunteer Matters volunteeringmatters.org.uk	×	×	~ syntactic filtering	×	×	×
	YourVolunteers yourvolunteers.com	×	×	~ syntactic filtering (time, interests)	×	×	×
Organisation INDEPENDENT	**linkedIn** linkedin.com	×	×	~ syntactic filtering	×	×	×
	Involver involver.com	×	×	✓ semantic matching (preferences)	×	✓ pers. „karma", rewards, statistics, fotos sharing	×
	GiveGab givegab.com	×	~ reviews	✓ semantic matching (competencies, interests)	×	✓ awards, challenges, social sharing	×
	Zeall zeall.us	×	~ reviews reports	✓ semantic matching (missions)	×	~ awards	~ missions

plethora of existing, commercial volunteer management systems (VMS) predominantly support NPOs in scheduling and allocating diverse tasks to volunteers and provide communication and coordination mechanisms for collaboration and cooperation [54]. In contrast to this NPO-centric view, however, we put the volunteer in the middle of concern by investigating the following core question: "How can the engagement of each volunteer be digitized and exploited in a life-long way". In order to provide a first step towards answering this question, Section 2 investigates in-depth on related approaches and identifies the challenges which have to be tackled to deal with the broad spectrum and peculiarities of volunteering. In Section 3 the vision of a next-generation VMS called iVolunteer is presented. The architecture for our envisioned digital eco-system is presented in Section 4, together with a discussion of the technologies and mechanisms which should be employed. Section 5 concludes the paper with a brief summary.

2 RELATED WORK

In order to derive requirements for the envisioned iVolunteer VMS the state of the art is discussed in detail in the following. Not least because of the world-wide omnipresence of volunteering, a plethora of mostly commercial systems is already available, from simple messaging hubs to full-fledged VMS supporting different phases of volunteering. Based on our in-depth evaluation of the state of the art on basis of a reference model for VMS comprising more than 100 evaluation criteria in [45], VMS can be roughly categorized into majority of *"organisation-centric systems"* focusing on volunteering support within NPOs and a few *"organisation-independent systems"* targeting especially the area of informal volunteering.

In Table 1, thirteen VMS falling into these two categories are evaluated. The rationale behind the selection of these systems was influenced by several factors, comprising among others (i) the comprehensiveness of the functionality provided being as closely related to iVolunteer as possible (especially the organisation-independent category), (ii) not only long-term players like Samaritan but also new innovative start-up systems like GiveGab or Zeall and finally (iii) also non-dedicated VMS like LinkedIn. Additionally, all of them are web-based or provide (in addition) a mobile front-end and have been empirically evaluated as most used systems. The criteria chosen for evaluation focus on the volunteer perspective. In this respect, volunteers want to get information about their *digital volunteer footprint*, e.g., which tasks have been fulfilled for which NPO. In order to support the volunteer to find the best matching tasks, a *volunteer marketplace* should provide according recommendations and means for brokerage. Finally, to motivate a lifelong volunteering, means for *encouragement* should be included in a VMS.

Table 2: Three Core Deficiencies of Existing VMS

Data Islands	Recommendation Weakness	Encouragement Deficits
• data stored **centrally** and **proprietary** → Lack of exploitation across the borders of IT-systems & organizations • data gathered just **once** in a **manual** fashion → no automated, continuous evolution based on accomplished tasks	• **semi-automatic** on basis of **simple filter** criteria → no automatic recommendations based on competencies or social relationships • **no proper balance** between adequacy and privacy → missing brokerage across NPOs	• incentives for volunteers s**hort-lived** → no long-term or sustainable encouragements • **present-oriented** → lack of mechanisms for personal carrier development through volunteer work

The findings concerning the evaluated systems are discussed in the following and are summarized in Table 2.

Data-Islands. Existing VMS are foremost walled, static data-islands since they are designed as black-boxes which can not be exploited across the NPOs borders in a trustworthy and confident way. Additionally, organization-centered approaches focus on the coordination of formal volunteering and do not cope with the need for incorporating also informal volunteers. For example, a volunteer has to state his personal data and competencies to every NPO she is engaged in. Finally, competencies are static in the way that the volunteer's qualifications are not automatically and continuously actualized on basis of volunteering activities.

Recommendation Weakness. The aforementioned data-islands additionally hamper the provision of intelligent recommendation- and brokering facilities across NPOs and prevent to achieve a proper balance between recommendation adequacy and privacy on the one hand and pre-conditions at demand-side and supply-side on the other hand. In this respect, current systems often only provide semi-automatic means for filtering task lists but miss more sophisticated means, e.g., matching on basis of a volunteer's competencies and a task's requirements or on basis of social relationships.

Encouragement Deficits. Existing VMS suffer from fundamental encouragement deficits since there are neither mechanisms for the preservation or acceleration of volunteering engagement nor support for the achievement of future personal development goals of volunteers, i.e., there are no means available for long-term encouragements or personal carrier developments of volunteers.

3 CHALLENGES AND VISION

Starting out from these three core deficiencies, several questions and challenges can be identified which should be addressed in next-generation IT-support for volunteering as illustrated in Figure 1, all of them focusing on the central metaphor "I am what I do" and the resulting core question "How can the engagement of each volunteer be digitized and exploited in a life-long way". Our envisioned system called iVOLUNTEER constitutes a first step towards finding answers to the questions and challenges by putting forward a digital ecosystem, i e., a system bringing together various technologies in order to put volunteers in the middle of concern and to facilitate lifelong volunteering. Thereby, the system focuses three core goals (cf. Figure 2) in order to tackle the aforementioned deficiencies and to take a first step towards fulfilling the challenges.

iVOLUNTEER FOOTPRINT. First and foremost, volunteers should be empowered to automatically track their volunteering activities in terms of an individual "digital volunteering pass" also called iVOLUNTEER FOOTPRINT. In order to respect a volunteer's sovereignty over his/her data, especially on competencies acquired during formal and informal volunteering activities, the confident storage of these qualifications in a decentralized, local repository is indispensable. However, this raises the question how to ensure traceability and immutability of volunteer work across NPOs? In order to achieve this, blockchain technology-based storage mechanisms are envisioned. To get from a static user profile to a more dynamic one, new competencies, which are achieved due to volunteering work, sould be automatically derived by means of (semantic) profiling mechanisms. To allow the external exploitation of these qualification, e.g., at the labour market or at the educational sector, adequate task-competency ontologies should be employed.

iVOLUNTEER MARKETPLACE. Second, on basis of the explicit and permanently actualized knowledge about the volunteers' qualifications, an optimal coordination between demand and supply for volunteering should be enabled, thus realizing an open iVOLUNTEER MARKETPLACE. This should be, in principal, independent of certain NPOs, thus also incorporating informal volunteers and help seeking people directly, but nevertheless by giving NPO's the possibility to take part as well. In order to coordinate offers and needs between NPOs and volunteers, adequate recommendations and sustainable

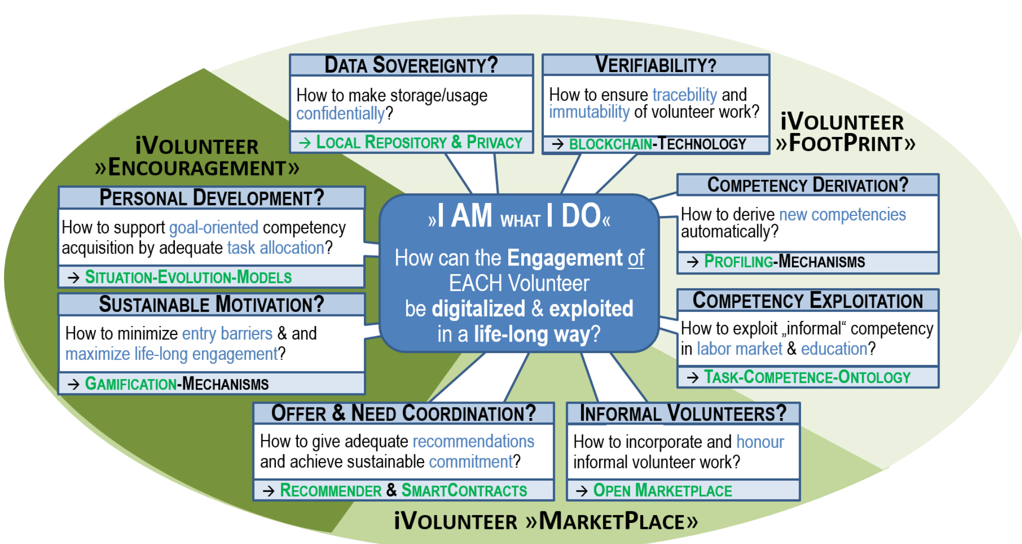

Figure 1: Core Challenges and Envisioned Solutions

Figure 2: Vision and Goals of iVolunteer

commitments need to be achieved. Recommender technologies using semantic-based similarity computations and brokering technologies, e.g., in terms of Blockchain Smart Contracts should be used for realizing this goal.

iVolunteer Encouragement. Third, again on basis of the volunteer's explicitly stored qualifications, a generic encouragement system is envisioned allowing a sustainable, long-term motivation of volunteers, called iVolunteer Encouragement. In order to minimize entry barriers and to maximize life-long engagement, gamification mechanisms seem to be a promising approach. Additionally, situation-evolution models allowing a goal-oriented volunteer task recommendation and allocation are foreseen for supporting the personal development of volunteers.

4 ARCHITECTURE AND IMPLEMENTATION ISSUES

The envisioned approach is discussed in the following along the three goals of iVolunteer. The overall system architecture is depicted in Figure 3, separating the system components in a *Trust Layer*, a *Semantic Layer*, an *Encouragement Layer* and a *Market Layer*. These different components will be discussed successively in the respective subsections.

4.1 Trust-guaranteed Persistence

Blockchains and NoSQL-DBs as Trust- and Persistency-Layer. Since iVolunteer intends to persist volunteering activities, assessments and acquired qualifications (i.e., skills and competencies) as so-called digital footprints, it is essential to ensure trustworthiness in terms of immutability and accountability on the one hand and to guarantee confidence in terms of utterly data sovereignty of the volunteers themselves on the other hand. As backbone technology we envision to employ blockchains [54], which are based on asymmetric cryptography and P2P-computing, being already omnipresent not only in the finance sector (e.g., BitCoin transactions) but also in health care (e.g., Trusted Medical Reporting), education (e.g., decentralized management of course certificates) or industry 4.0 (e.g., Blockchain-powered Supply-Chain-Management) [37], thus turning the Social Web into a Trusted Web, allowing to persist arbitrary digital assets in a decentralized but fully trustworthy way.

Footprints represent digital assets, no matter if they were manually registered through volunteers themselves, NPOs or help seekers or if they were derived on basis of semi-automatic profilers (cf. below) or imported by means of appropriate adapters (cf. our work in [23, 51]) from social networks like linkedIn or stackoverflow.com (e.g. micro-tasks). In order to ensure trustworthiness, the footprints are persisted within a "personal" repository which is exclusive to the volunteers themselves (e.g., locally, on a private NAS). Each entry is additionally persisted within a distributed blockchain (cf. `Trustifier` in Figure 3) in form of an encrypted hash-value (e.g., on basis of ECDSA [21]) only, thus adhering to a "lightweight" blockchain approach. Entries are additionally digitally signed (e.g., by means of SHA-256 [40]) using the private keys of the originator and the receiver.

Resembling the common procedure in existing blockchain-based applications, the entries are assembled to blocks and get inextricably linked with each other by means of a hash-function to achieve trustworthiness – manipulation impossible, authentication possible anytime (cf. `Authentifier` in Figure 3). For this, a P2P-network [48] will be build up, where the blockchain is distributed and redundantly persisted on the peer-nodes managed by NPOs or volunteers themselves. In order to allow new entries to be authenticated through all nodes in a practicable but nevertheless trustworthy way, it is crucial to choose a consensus-mechanism [41] which is adequate for the peculiarities of iVolunteer.

Considering different existing open source blockchain implementations like OpenChain [7] or MultiChain [38], from a present-day perspective, BigchainDB [33] seems to be most promising, since this approach allows for persisting large data volumes aside the blockchain on basis of NoSQL-DBs [25]. Thereby, not only the need for a lightweight blockchain is fulfilled, but also the requirement for a personal `FootPrint-Repository` which is able to store *semi-structured* or *unstructured data* (e.g., textual descriptions of a volunteer's competencies or of a task).

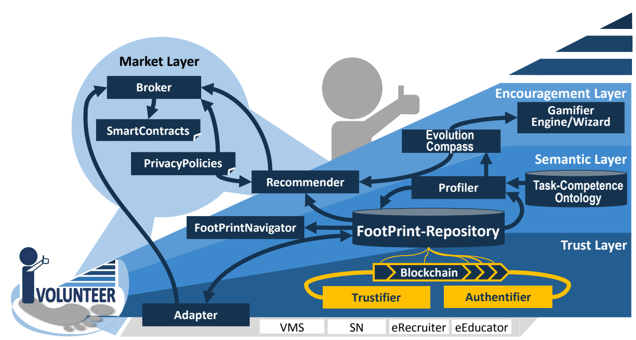

Figure 3: Technical Architecture of iVolunteer

Profiler and Ontologies for Semantic-driven Deduction of Informal Competencies. A semi-automatic deduction of informal competencies which are gained by informal learning [29] in the course of volunteer activities should be performed in iVolunteer on basis of generic, rule-based `Profilers` (e.g., [18]) and corresponding reasoning techniques [9]. These profilers are based on according task-competence-ontologies, consisting of rather generic parts in terms of an upper-ontology as well as domain-specific parts, thus representing the peculiarities of certain volunteer sectors. For this, semantic technologies will be employed, e.g., Web Ontology Language (OWL) [24, 28, 42] and Description Logics (DL) [2]. The ontologies will be based on existing work in the areas of Human Resource Management [32], eRecruitment [5], eLearning as well as Competency and Reputation Management [52]. In this respect it has to be emphasized that not only direct relationships between tasks and competencies will be formalized, but also indirect associations which can be exploited from semantic relationships between both, tasks and competencies (e.g., in case of partOf-competency relationships, the overall competency can be derived as soon as all separate competencies are achieved). Moreover, arbitrary complex interconnections can be represented within the ontologies by means of dedicated derivation rules, meaning also that competencies can be, e.g., derived from textual task descriptions based on Information Retrieval/Extraction (IR/IE)-techniques [31]. The developed generic profilers will be managed within an open, i.e., extensible `ProfilerLibrary`, similar to the task-competence ontology, thus allowing the integration of external sources (e.g., HR-XML [47], InLOC [17], eLearning-Ontologies [15]) and the development of new profilers.

4.2 Intelligent Brokerage of Voluntary Work

Recommender for collaborative, content- and semantic-driven MatchMaking. In order to achieve an optimal coordination between volunteers, NPOs and help seekers, a so-called iVolunteer `Recommender` providing an intelligent MatchMaking-component will be developed by integrating and adapting existing collaborative and content-based matching approaches [4, 10, 30]. The goal is to recommend "best"-fitting tasks automatically, thereby minimizing the acceptance barrier for certain tasks and at the same time maximizing the benefit for all stakeholders. Collaborative matching approaches should be employed to generate recommendations by analysing the usage-behaviour of all parties at the iVolunteer MarketPlace as well as the decision taken by other users and most important also by incorporating existing social relationships between users (e.g., recommending tasks which have already been selected by other closely-related volunteers or SN-friends).

Complementary to that, content-based approaches are used in order to recommend tasks which have "similar" properties as already selected ones (e.g., find tasks which are comparable wrt. location and temporal conditions on basis of spatio-temporal analysis). No matter if collaborative or content-based matching is used – a key requirement is to provide appropriate similarity metrics, going beyond simple syntactical/structural matchings by using semantic-driven matchmaking, e.g., on basis of ontologies. The crucial challenge will be to ensure a proper user-perceived adequacy of recommendations. The approach should also be aware of eventually occurring "Filter Bubbles" [53].

Finally, a challenge, which is especially relevant for real-world application of iVolunteer, is the consideration of unstructured data, e.g., textual competency and/or task descriptions as a basis for recommendations. For this, again IR/IE-techniques [31, 44] will be employed, whereby systems like Elastic-Search [11] may be a promising starting point.

PrivacyPolicies and SmartContracts for confident and committed Brokerage. The recommendations of tasks or volunteers by the iVolunteer-`Recommender` component should, on the one hand, only use data which has been explicitly released by the respective volunteer to respect data sovereignty for volunteers but should on the other hand lead to obligatory agreements between the demanding and the supplying party. The basis to achieve these contradictory goals, is to follow a white-box approach in contrast to most existing black-box based VMS, meaning that users are able to personalize the recommender in a way that the rationale behind all recommendations is fully transparent.

To ensure the fundamental principle of absolute data sovereignty, users are empowered to "negotiate" the subjective balance between revealing data for the public and confidential data from the personal repository necessary to produce adequate recommendations. This is realized by means of the iVolunteer `Broker` and dynamically adaptable `PrivacyPolicies` as already proposed in our TheHiddenU-project in another context [22, 26]. Additionally it should be possible to negotiate different parameters (e.g., if a certain task would be adequate but the foreseen date is inconvenient), which are specified on basis of a rule-based language [18].

Finally, to determine that if volunteers meet certain (post-)conditions (e.g., task fulfillment) and at the same time NPOs fulfill certain (pre-)conditions (e.g., confirmation of a certain competency and willingness to volunteer for a certain time period honoured through an entry in the blockchain), blockchain-based *Smart Contracts* [27] will be employed. Smart Contracts contain a formalized representation of the pre- and post-conditions which are persisted within the blockchain. As generic development platform, Ethereum [13] provides promising functionality.

4.3 Generic Incentive System

Gamifier Engine and Gamifier Wizard for preservation and increase of intrinsic Engagements. Our goal is to develop a generic but at the same time customizable `GamifierEngine` for iVolunteer which allows to incorporate gamification-elements in a semi-automatic way inducing intrinsic and long-term motivational effects on volunteers [1, 14, 36]. Starting out from a so-called 4P-analysis [34], the realization of gamification concepts with respect to the well-known Self-Determination Theory (SDT) [8] and the commonly accepted HEXAD-player types [49] should be determined based on [6], from the viewpoint of NPOs and volunteers. Consequently, gamification strategies have to be designed by mapping suitable player types (e.g., socializer or achiever) to adequate gamification elements [19, 35] according to the peculiarities of the volunteer sector.

At run-time, a semi-automatic classification of volunteers according to the player types is performed by the `Gamifier Engine`, based on the revealed iVolunteer FootPrint at the iVolunteer MarketPlace. The results of this analysis are also employed for a continuous, situation-adaptive refinement of personalized gamification strategies [20]. The goal is to get the users into a so-called "flow-state" [39] which is sustainable, thereby increasing the engagement of volunteers and achieving long-term motivational effects.

The `GamifierEngine` should be extensible through the support of a `Game-Mechanics-Layer` [35] allowing to integrate additional layers or to deactivate existing ones. In order to prevent any negative effects of gamification elements, a so-called `GamifierWizard` should facilitate the configuration and adaptation of the diverse gamification mechanisms.

FootPrintNavigator and EvolutionCompass for goal-oriented Personal Development. A crucial success factor in the context of iVolunteer Encouragement is to raise awareness of the volunteers concerning their self-efficacy. For this, a `FootPrintNavigator` is foreseen, allowing to visualize the footprint entries within the personal repository in an adequate way, e.g., based on Kiviat-graphs or Ishikawa-diagrams. In the sense of traceability of informal learning processes [29], awareness should be raised which volunteering activities led to which kind of competences as well as in which way they were derived through profiler. In this regard, different levels of granularity and aggregation as well as spatio-temporal aspects (e.g., mobility of volunteers or phase of life) play a central role. To ensure a proper exploitation of the benefits achieved by volunteering activities, the `FootPrintNavigator` should be able to compute interrelationships and aggregations (e.g., the "social capital" of a volunteer) by means of deductive profiler on basis of the iVolunteer FootPrint and machine learning techniques [16]. This aggregated visualization of the value of volunteering constitutes a substantial incentive for volunteers, NPOs and the society as a whole. Another aim is to allow volunteers to reuse and exchange arbitrary parts of the iVolunteer FootPrint and thus to exploit them for different purposes (e.g., job applications or certifications at educational institutions). This should be achieved by providing appropriate views and adapters exhibiting export functionality for different data formats (e.g., Europass).

Finally, the definition and traceability of personal development goals should be explicitly supported by means of a `EvolutionCompass` using so-called situation evolution models, a state-machine-based formalism which we successfully applied in the area of situation awareness systems [3, 12, 43]. The respective situation evolution models will be developed by resembling findings in the area of human resource development and goal management systems [32] and will be used to monitor the path for reaching the personal development goals on basis of continuously updated entries in the personal repository on basis of the task-competence-ontology and by incorporating the `Recommender` (e.g., by pro-actively recommending volunteer activities which are suitable to move forward on the path for reaching the personal goals).

5 CONCLUSION

In this paper, we presented our vision of next-generation IT support for life-long volunteering, one of the most indispensable cornerstones of our society. We tried to figure out the massive changes the volunteering sector has been facing throughout the last decade and provided a discussion how far existing VMS are able to cope with that new situation. In sharp contrast to existing systems mainly targeting the scheduling and allocation of volunteer tasks, we proposed to put the volunteer in the middle of concern, adhering to the metaphor "I Am what I Do". In this respect, our envisioned system iVolunteer aims to explicitly support the trustworthy and confident digitization and exploitation of volunteer engagement, puts forward an open volunteering marketplace based on intelligent recommendation and brokering mechanisms and finally emphasizes the need for long-term encouragement based on gamification mechanisms and goal-oriented personal development support. Based on this vision, a concrete technical architecture was sketched out and appropriate technologies and mechanisms were discussed as proper basis for the realization of iVolunteer.

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