Social Network-Based Knowledge, Content, and Software Asset Management Supporting Collaborative and Co-Creative Innovation

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Abstract

This paper addresses a number of scenarios for the collaborative and co-creative aggregation of innovation knowledge, content, and corresponding software assets from social network-based software repositories supporting, e.g., Source Code Management (SCM), such as e.g., GitHub ("Build software better, together," 2017). In the resulting collaborative, co-creative, and social-network enabled innovation approach, such innovation knowledge resources, supplementary content, and corresponding software assets are aggregated into a service-based, social network-enabled, knowledge-driven ecosystem portal supporting innovation for an exemplary use case of applied games communities (i.e. AG researchers, software developers, and players). In addition, we propose methods for the harvesting of relevant knowledge contained in know-how oriented co-creative user-interactions surrounding these assets such as Stack Overflow ("Stack Overflow," 2017), as well as the long-term archival of these knowledge resources to capture implicit innovation and co-creation knowledge associated with the software-assets. The paper will explain the implementation of the software harvesting as well as innovation and co-creation knowledge acquisition scenario in detail.

1 Introduction and motivation

The market for non-leisure games (Applied Games, AGs) is part of an exemplar emerging innovative, technology- and knowhow-driven ecosystem. However, as such it is still fragmented and needs to achieve critical mass. Nevertheless, its growth potential is widely recognized and even suggested to exceed the growth potential of, e.g., the leisure games market. Therefore, to become more competitive the relevant applied gaming independent software developers and small and medium sized enterprises as well as their customer and user communities require innovation support.

The launch of innovative products and services by Small and Medium-sized Enterprises (SMEs) of the AG industry constitutes an enormous challenge considering fierce global competition combined on the one hand and limited budgets on the other hand. Therefore, such SMEs need external, i.e., collaborative and co-creative innovation support, e.g., from research groups and independent innovative software developers, enabling them to collaboratively and co-creatively achieve a crucial competitive advantage of being faster than others (Paukert et al., 2011). Accelerating the discovery of new (scientific & technical, S&T) findings, their take-up into innovative software developments including the technical realization of the innovation as well as the market launch (Grupp, 1997) (Haß, 1983) has to be fostered. The success of this process is increasingly dependent on the use of advanced information and knowledge technologies for building web-based and service-oriented innovation ecosystem support environments that support the collaborative and co-creative knowledge sharing and corresponding collaborative and co-creative innovation processes systematically and efficiently (Specht et al., 2002). Such environments depend on the availability of a number of advanced Information, Content, and Knowledge Management (ICKM) technologies

and processes and have to adapt to a wide variety of innovative practices, cultures, organizational context, business models, and application areas (Becker et al., 2015). Independent of the domain, innovation is a knowledge-intensive process (Paukert et al., 2011). Therefore, the RAGE project (netvision, 2017) is an exemplary reference use case aiming at supporting this challenge. RAGE will help to seize these opportunities by making available an interoperable set of innovative Applied Game (AG) technology assets, as well as knowledge and supplementary content about proven innovative practices of co-creatively using software-asset based AG innovations in various real-world contexts. As described in (Salman et al., 2015), RAGE will finally provide a centralized access to a wide range of innovative applied gaming software-assets, relevant innovation and co-creation information, knowledge, learning content, and related social-network enabled community services, as well as related scientific and technical documents and media (e.g., publications, presentations) including knowledge resources like, e.g., taxonomies, educational resources, quality assurance dialogs etc. within an online innovation co-creation community portal called the RAGE Knowledge Management Ecosystem Portal (RAGE KM-EP).

2 Problem statement, goals, and objectives

The main objectives of the RAGE KM-EP are to allow its participants to get hold of advanced, innovative but at the same time co-creatively usable best practice knowledge, supplementary content resources, and technology assets (supporting technology push), to enable them effectively (Manlio Del Giudice et al., 2014) and efficiently to get access to the associated innovative business cases and commercial opportunities. Therefore, the main driver of the RAGE KM-EP is to connect, equip, and enable SMEs and individual industry players (e.g., independent innovative game developers) with a set of advanced technology resources (so-called assets) and strategies (i.e., know-how) from academic Research and Technical Development (RTD) communities to strengthen their capacities to penetrate an emerging market (non-leisure) and to develop an innovative, i.e., unique sales position. The initial concepts, ideas, and awareness supporting the ideation phase of the innovation process come through the content aggregation of Scientific and Technical (S&T) publications, presentations and other supplementary Information-, Content- and Knowledge- (ICK) resources as described in (Salman et al., 2016) along, e.g., the integration with the Mendeley (“Homepage | Mendeley,” 2017) and SlideShare (“SlideShare.net,” 2017) platforms.
In consequence, the integration with the GitHub software repository and its Source Code Management (SCM) facilitates the integration and aggregation of software-assets from social-network based systems into the development phase of the innovation and co-creation processes. In this way, AG researchers as well as independent innovative software developers are seamlessly enabled to import innovative AG software-assets into the RAGE KM-EP. The imported assets will be, on the one hand, semantically annotated to support searching, browsing, and access and on the other hand, will be linked to other objects (i.e., taxonomies, supplementary documents, media, and educational resources, as well as best practice knowhow as, e.g., contained in Question and Answer (Q&A) dialogs etc.) within the RAGE KM-EP. In this way, the RAGE KM-EP will realize centralized access to a wide range of AG innovation ICK resources referring to innovative AG software-assets, services, and resources by the arrangement of a well-managed and structured asset repository, digital library, and media archive system. The Stack Overflow system, e.g., supports AG researchers and innovative independent software developers to post questions to the AG Stack Overflow community and to co-creatively get answers, comments, notifications, etc. without switching from the RAGE KM-EP to Stack Overflow and vice versa. Moreover, relevant AG best practice knowledge can be imported into the KM-EP as, e.g., a Q&A dialog which on the other hand, can be semantically annotated and analyzed by means of applying technologies for, e.g., Natural Language Analysis (NLA) for supporting discourse analysis. That will support to arrange, e.g., co-creation workshops and offer training courses on an online training portal, covering training

for developers and educators, self-sustainable co-creative production of innovation-oriented assets and documentation, training material, workshops, and collaboration activities.
In the remainder of this paper, section 3 describes the relevant State of the Art and Related Work with respect to relevant portal technologies supporting KM within innovation and co-creation processes considering the model of knowledge management success as described in (Jennex and Olfman, 2010) (Jennex et al., 2016). Section 4 provides an introduction to the use case scenarios of the GitHub and Stack Overflow KM-EP integration based on knowledge- and service-driven perspectives for the digital innovation and co-creation ecosystem environment. Furthermore, section 5, more specifically and technically reviews the integration possibilities of GitHub ("Build software better, together," 2017) and Stack Overflow ("Stack Overflow," 2017) into the RAGE KM-EP using their Application Programming Interfaces (APIs). Besides, this section will describe the implementation of the RAGE KM-EP GitHub and Stack Overflow integration use cases that are described in section 4. Finally, the paper will present an initial cognitive walkthrough evaluation as well as conclusions and future works.

3 State of the art and related work

The work presented in this paper is related to a number of topics in RTD. The conceptual approach of the KM-EP is based on the reflections of KM (Bullinger et al., 1997) and Service Management (Fließ, 2008). Building, amongst others, on the SEKI model of Nonaka und Takeuchi (Nonaka and Takeuchi, 1995), the Innovation Knowledge Lifecycle Meta Model (IKLC) extends the basic model with respect to supporting innovation (Paukert et al., 2011). Defined by people, especially practitioners, in a shared domain engaging in a process of collective learning, innovation, and co-creation (Wenger, 2011), the KM-EP is aiming at creating and supporting the digital environment for a virtual Communities of Practice (VCoP) in the innovation domain AG to enable successful asset-based innovation ideation, conceptualization, proof-of-concept, and finally co-creative innovation, i.e., application solution development and will later also support corresponding commercialization.
A well-known similar example of related work is GitHub ("Build software better, together," 2017). GitHub is a software repository and SCM portal for developers, which currently has over 10 million users. Users can upload or start a software project and collaborate co-creatively on its development with other users in the community (Dabbish et al., 2012). Currently active and past projects are retained and can be used as examples and sources of knowledge. GitHub provides an API ("GitHub API v3 | GitHub Developer Guide," 2017) based on the REST service-oriented architecture (Fielding, 2000) which can be used for integration with the RAGE KM-EP. The current version (v3) of the GitHub RESTful API supports full read- and write-access on the GitHub resources (i.e., repositories, organizations, users, issues, statistics, activities, commits and tags).
Stack Exchange ("Hot Questions - Stack Exchange," 2017) is another example of a collaborative innovation and co-creation support environment. Stack Exchange is a popular Q&A online community platform. Users can post questions on a topic and also associate the question with a maximum number of five tags, other users provide answers. Besides, participants are not compensated, e.g., financially for their services, but users do gain reputation points when other users "up-vote" their questions and/or answers. This approach as a co-creatively learning community with a strong reputation-seeking element creates valuable public good in the sense of a knowledge resource. Therefore, Posnett et al. named Stack Exchange as a gift economy (Posnett et al., 2012). One of the most important communities of Stack Exchange is Stack Overflow, the preeminent site for programmers to find, ask, and answer questions about software development. Similarly, Stack Exchange provides a RESTful API which can be used to post and pull questions and answers, as well as to get access to the resources of Stack Exchange (i.e., questions, answers, comments, badges, events, user information and tags) from other systems and platforms.

The KM-EP was built based on Typo3 (Binh Vu, 2015a) and, therefore, can be extended with the help of Typo3 extensions. Our work extends the RAGE KM-EP modules *Content & Knowledge Management and User & Community Management.*

4 Modelling the KM-EP platform and its use case scenarios

The concept of a supporting collaborative and co-creative innovation processes by creating an adequate innovation and co-creation ecosystem support environment considering incoming innovation opportunities as well as innovation needs and demands, harvesting and working with outputs of RTD, i.e., innovation knowledge creation processes and the satisfaction of innovation demands based on innovative RTD outcomes has been extended to the concept of the KM-EP. Additionally, our BMC of the collaborative and co-creative KM-EP environment is based on the business model framework as described by Osterwalder et al. in (Osterwalder and Pigneur, 2011) using nine basic building blocks, covering four areas of business: Customers, offer, infrastructure and financial aspects. The framework has been used to analyze the Leisure and Applied Games industry business models.

Whilst the BMC is a tool by which businesses can effectively articulate their value proposition, it does have its limitations critically in the very linear way it presents transactions and relationships. The RAGE KM-EP RTD requires a more sophisticated and richer approach provided by Platform Design (Choudary, 2015). The Platform Design provides us with attributes of modern product driven services, and these attributes should remain at the core of the products and services provided through the RAGE KM-EP, namely fast, personalized, relevant and human. Besides, as the AG market and its innovation and co-creation ecosystem is fragmented the Platform Design approach provides RAGE with the opportunity to “bring order to a disordered market” and to facilitate the development of “business models that allow multiple sides (producers and consumers) to interact by providing an infrastructure that connects them” (Choudary, 2015). Platform Design thinking incorporates the elements of service design.

To ensure the goal of co-creatively stimulating both the demand and supply side for applied games, a fundamental disruptive (Christensen et al., 2010) action is required, with the aim of achieving a state of systemic innovation within the sector. In this way, the asset-based approach of the RAGE KM-EP is transformative: it requires the development of new, i.e., innovative and co-creative business models and takes the sector beyond the “products and customer service” narrative in to the collaborative and co-creative platform design narrative.

Taken the SEKI and IKLC considerations into account (Becker et al., 2015), the KM process underlying the KM-EP can be described as follows. Driven by the need for competitive products and services, and at the same time acting responsive, i.e., co-creative to the customer’s fast changing requirements the AG industry indicates a high demand for collaborative and co-creative innovation. To establish an appropriate innovation and co-creation support environment and at the same time a kind of a body of state-of-the-art and best-practice knowledge to support these the KM-EP supports collecting conceptual AG RTD knowledge, ideas, methods, and corresponding document and media resources (e.g., scientific publications and presentations), software-assets, documentation, Q&A dialogs, training material, and best practices from the heterogeneous and dispersed AG landscape to provide relevant communities the opportunity to co-creatively participate, to share and to benefit from these RTD resources to create new and innovative outcomes. In this way the content aggregation of, e.g., S&T publications and presentations as described in (Salman et al., 2016) along the integration with the Mendeley (“Homepage | Mendeley,” 2017) and SlideShare (“SlideShare.net,” 2017) platforms has already been implemented. The following subsections describe and model the integration with the GitHub and Stack Overflow based innovation and co-creation support features using the Unified Modeling Language (UML) (“Welcome To UML Web Site!,” 2017). The detailed modeling of the RAGE

KM-EP BMC is an ongoing agile and co-creative innovation process itself and can (because of limitations in space) not be presented at this time in this paper.

5 Service-driven approach and the GitHub use case scenarios

Taken the modelled features of the RAGE KM-EP into account, the KM-EP is integrating streams of innovation and co-creation knowledge, content and asset resources of the innovation "supply side", i.e. from RTD actors and is making it collaboratively available to the "demand side" i.e. innovative software developers and SMEs in the AG innovation ecosystem.
Thus, the offered features received a service character. In this case S&T innovation and co-creation knowledge represents an intangible commodity and the result of the service process has an intangible character as well. The process could be highly integrative, if the customer, frequently users/consumers themselves, will later be integrated constantly into a co-creative phase of an innovation preparation process (Corsten and Gössinger, 2007). An advantage of the system is the automated execution of the described service processes. In consequence, the integration with the GitHub software repository permits RAGE KM-EP users to import software-assets including their metadata into the RAGE KM-EP. Furthermore, software-assets can be annotated with semantic representations and classified with taxonomies. In this way, AG software-assets (e.g. software-frameworks) can be found as well as effectively be accessed and re-used within the RAGE KM-EP. AG Asset-developers can, e.g., import their own repositories into the RAGE KM-EP while administrators are allowed to import additional other repositories using a Uniform Resource Locator (URL) of repositories. RAGE KM-EP users can then look for AG assets using the full-text as well as the semantic search engine which is integrated into the RAGE KM-EP or by means of faceted browsing through the taxonomies within the RAGE KM-EP. Besides, RAGE users can also download the entire repository as a ZIP-file that can be archived using an archiving or even long term archiving system based on OAI-PMH ("Open Archives Initiative Protocol for Metadata Harvesting," 2017). Another use case of the integration with GitHub which is considered to be implemented in the future is to keep the imported repository along with its associated issues, comments, changes, etc., synchronized with the original one from GitHub. This helps to support the user collaboration, workflows, and co-creative communication. Likewise, the Travis CI ("Travis CI - Test and Deploy Your Code with Confidence," 2017) platform uses synchronization technology based on WebHook ("Web Hooks / FrontPage," 2017). Hence, RAGE KM-EP users stay well-informed about the issues, changes, and events from the community uninterruptedly. The described use case scenarios show that expert knowledge, information, and expertise from outside the user community, as well as community collaboration support were taken into account.

6 Knowledge-driven approach and the Stack Overflow use case scenarios

To handle the available domain-specific tacit knowledge within a technology based infrastructure it must be transformed into machine-readable representation. Therefore, the applied gaming users or user groups have to be supported to transform their co-creative communication, information, Q&A dialogs, and experiences into digital objects (e.g., text, dialog, image, video, recorded speech, etc.) and provide them to the related AG RTD communities. The integration with the Stack Overflow as a collaborative co-creation support feature surrounding the AG-assets permit RAGE KM-EP users to post questions to the Stack Overflow community without switching from the RAGE KM-EP to Stack Overflow and to get answers about the posted questions directly back into the RAGE KM-EP. Thus, Q&A dialogs are transformed into digital co-creation support objects which can be archived, shared, accessed, disseminated, and re-used (again using an archiving system based on OAI-PMH ("Open Archives Initiative Protocol for Metadata Harvesting," 2017)), annotated with semantic representations, and classified with taxonomies.

After a successful authentication and authorization RAGE KM-EP users can post new questions or edit a given one (i.e. changes the question, change its associated tags, add a comment, etc.).
Furthermore, users can browse the answers within the RAGE KM-EP for a posted question. Another use case similar to the synchronization of the GitHub repository is to track the questions, answers, and their related changes such as issues and comments in order to support users' co-creative collaboration, interaction, and communication. Besides, the KM-EP will use the collective data of Stack Overflow (i.e., questions, answers, associated tags, and related user data) in order to fulfill the automated expert recommendation use case. Thus, the KM-EP supports its users to find content that arose from harvesting tacit knowledge and curating it with explicit SA representations and to adapt, extend, and link/enrich it in this way semantically with additional supplementary background knowledge to support later re-use and especially internalization of this knowledge (i.e., Internalization as from the SEKI point of view). This step is called cognitive value creation or the generation of knowledge (Lave and Wenger, 1991).
Connecting to this process the KM-EP offers Internalization (as understood in SEKI) resp. knowledge transfer support in the sense of a learning management process. It serves as a huge knowledge library or database. E.g., Stack Overflow assigns reputations to user profiles to measure how much the community trust the user (i.e., measurement of the users' competence). The more reputation users earn, the more privileges they can gain.

7 Proof of concept prototype to support co-creative software asset integration

The following section presents the main technical integration possibilities of the GitHub and the Stack Overflow in the backend and frontend of the RAGE KM-EP, as well as the implementation for the use cases that were described in section 4. Figure 1 displays our software architecture extension of the two components Ingest and Content Manager within the RAGE KM-EP.
The data integration is based on the Mediator/Wrapper architecture as described in (Wiederhold, 1992) using the RESTful APIs of the GitHub and Stack Exchange ("GitHub API v3 | GitHub Developer Guide," 2017) ("Stack Exchange API," 2017). The RAGE KM-EP extensions have to be

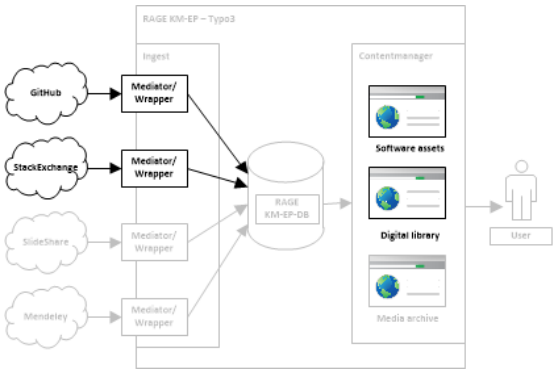

Figure 1. Ingest and content manager: extending the KM-EP software architecture

registered on the GitHub and Stack Exchange developer portal as an application and a valid "client ID and secret key" has to be available in order to be allowed to use their APIs. Besides, security issues are taken into account to get access to the resources and software-assets using the OpenID ("OpenID Foundation website," 2017), the OAuth Protocol ("OAuth 2.0 — OAuth," 2017), and HTTPs for authentication and authorization. We use the MythCRM-System (Binh Vu, 2015b) to manage applications' and users' access based on role management. Both extensions GitHub as well as Stack Exchange are registered as an OpenID-Client in the MythCRM-System. Furthermore, users have to be registered too, and associated to roles in order to get access to the resources and to be allowed to perform functions (e.g., import private or public repositories from GitHub, post

questions and import Q&A dialogs from Stack Exchange, etc.) of the GitHub-, and Stack Exchange-extensions. Furthermore, the integration of the user interface is based on the Model View Controller (MVC) paradigm as described in Extbase for Typo3. We use the owner name of the repository and the repository name to identify the repository that would be read. All metadata of the repository including the RAGE-Asset Metadata (if available) are displayed in separated tabs and categories in order to enhance the usability and the user-friendliness of the implemented interface (cf. section 6). After that, the user can either select repositories or search for a public repository using a repository's URL and import them. Once a repository was imported, the metadata-array will be automatically mapped to the attributes of the RAGE KM-EP software-object. Moreover, user can also adjust the mapping-table manually. On the other hand, the Stack Exchange API returns every response in a common "wrapper" object using JSON or JSONP with the callback query parameter. The API support three object types i.e., question-, answer-, and user-object. Each object has an ID which we use to identify contents of a posted object. Besides, each question-object is assigned to a user. The answers' references of the question are saved in the field "answers" as an array of answer-objects. We use the associated tags to identify questions and answers that are interesting or relevant to the AG developers. A tag is a word or phrase that describes the topic of the question or the answer. The answer-, and the user-object have similar structure to the question-object which makes the integration and the mapping of the data to the RAGE KM-EP attributes easy.

8 Preliminary evaluation

In order to drive decision making and further RTD of our prototype and designs we conducted a cognitive walkthrough (Polson et al., 1992) with AG RTD experts from the user communities of the RAGE project for each use case described in session 4. This preliminary, i.e., initial qualitative evaluation is necessary in order to ensure that functions adequately meet the requirements and needs of the targeted AG user communities. This section presents a preliminary evaluation based on cognitive walkthrough for the integration use case with GitHub. Figure 2 displays the user interface after successfully connection to the GitHub repository of the logged in user. The user can then import his own repositories (cf. Figure 5, tab "your repositories") or search for a public repository using an URL (cf. Figure 2, tab "URL search"). The assets of the selected repositories are displayed in the tab "Assets to import" (cf. Figure 2). There the user can select assets to be imported. Figure 3 shows the data mapping interface of the imported asset. User can accept the proposed data mapping or edit it.

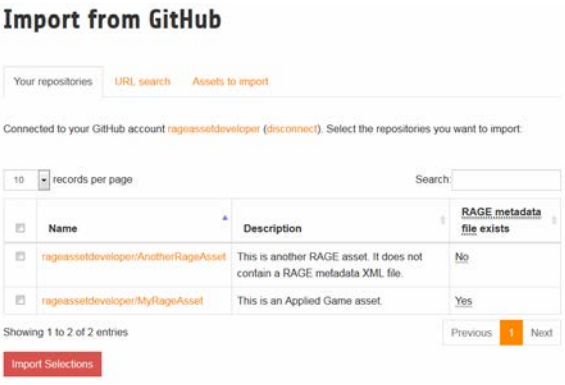

Figure 3. KM-EP User Interface after successfully connecting to the GitHub repository

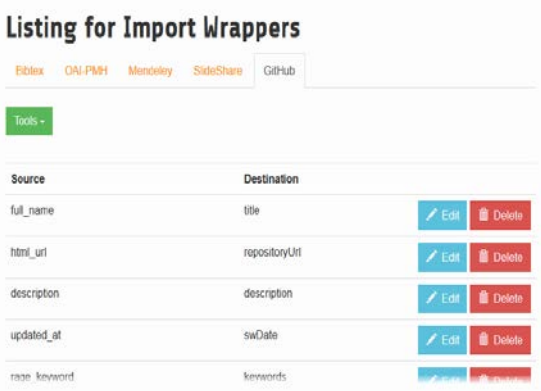

Figure 2. Data mapping interface of the software assets

9 Conclusion and outlook

In summary, it is a big advantage to aim at supporting the integration of software repositories and SCM such as GitHub, as well as collaboration- and co-creation Q&A support environments such as Stack Overflow including content, information, and knowledge capturing, management, sharing, and dissemination support through their RESTful API into the KM-EP. This will on the one hand facilitate to provide a wide range of supporting services in the field of collaborative innovation and co-creation knowledge transfer and -creation to overcome low market access and small market share of SMEs and independent innovative software developers in the innovation domain as, e.g., in our reference use case the AG market, to create new effective technology based assets in order to build new innovative products and services, e.g., learning-oriented games. On the other hand, it focuses on identifying collaboration and co-creation opportunities between individuals and among groups, to support matchmaking, collaboration, ideation, conceptualization, proof-of-concept, as well co-creation and collaborative innovation of application solutions between stakeholders, and to identify and provide support for innovation opportunities and creativity efforts. That allows communities (such as technology providers, game developers and educators, game industries and researchers) to engage themselves in a co-creative VCoP, create their own assets and post them to the ecosystem's repository without major effort and to benefit from achieving (business) results.

The innovation potential of the KM-EP based collaborative and co-creative ICKM and innovation process support is based on the following innovation and co-creation ICK resource harvesting, management, and access features: a huge, mostly entire collection of community specific innovation and co-creation knowledge (e.g., content like media objects, software-assets, Q&A dialogs, and best practices), a structured approach of innovation and co-creation knowledge access, search, browse, collaboration and co-creation tools, as well as social-network enabled NLA discourse analysis tools to foster efficient innovation and co-creation knowledge creation and transformation processes into marketable technology assets. Consequently, these new assets will be used to produce new applied games or game-based learning application solutions. Hence, the economic value of the developed software assets including their innovation and co-creation ICK resources will be economized and could be monetarily evaluated at the market. Therefore, innovation and co-creation ICK resources become a supplementary economic asset and the process of innovation and co-creation ICK resource creation, harvesting, archival, and reuse becomes a value adding service. With the design and development of a comprehensive approach as pursued with the KM-EP, ethical issues are taken into account. The integration of users' profiles from different resources, as well as the use of features carrying out analyses on top of KM-EP user data have ethical implications in terms of privacy and data protection and require appropriate information and consent in the terms and conditions of use, as well as compliance to national and international data protection regulations. The consideration of such ethical and legal requirements is incorporated in the system design and development process in terms of an ethics-by-design approach. This means that data protection and privacy is already taken into account when the system is being designed. Design principles, such as purpose binding, ensure that personal information is only accessible, if there is a need for it when performing a certain action. The system can also control data access by respecting personal settings which data should be available to others or the public. Other ethics-enabled features include the modification or deletion of personal data. Therefore, the KM-EP supports the interconnectedness, the knowledge exchange and the harmonization of standards of the applied gaming sector. Coupled with suitable business models the KM-EP is aiming at helping the AG industry to collaboratively and co-creatively drive strategy, support problem solving, build capabilities and knowledge competencies, cross fertilize ideas and increase opportunities for co-creative innovation to assert themselves against big games companies.

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References

Becker, J., Lankveld, G. van, Steiner, C., Hemmje, M., 2015. Realizing an Applied Gaming Ecosystem: Towards Supporting Service-based Innovation Knowledge Management and Transfer, in: Proceedings of the 4th International Conference on Games and Learning Alliance, GALA 2015. Presented at the GALA Conference, Rome, Italy.

Binh Vu, D., 2015a. Realizing an Applied Gaming Ecosystem - Extending an Education Portal Suite towards an Ecosystem Portal (Master Thesis). Technische Universität Darmstadt, Darmstadt, Germany.

Binh Vu, D., 2015b. Customer Relationship Management based on Identity Management for Scientific Associations (Bachelor Thesis). Technische Universität Darmstadt, Darmstadt, Germany.

Build software better, together [WWW Document], 2017. . GitHub. URL https://github.com (accessed 5.19.17).

Bullinger, H.-J., Wörner, K., Prieto, J., 1997. Wissensmanagement heute. Fraunhofer Institut für Arbeitswirtschaft und Organisation, Stuttgart.

Choudary, S.P., 2015. Platform Scale: How an emerging business model helps startups build large empires with minimum investment, First. ed. Platform Thinking Labs.

Christensen, C., Johnson, C.W., Horn, M.B., 2010. Disrupting Class: How Disruptive Innovation Will Change the Way the World Learns, Updated, Expanded ed. ed. McGraw-Hill Professional, New York.

Corsten, H., Gössinger, R., 2007. Dienstleistungsmanagement, 5. Auflage. ed. Oldenbourg Wissenschaftsverlag.

Dabbish, L., Stuart, C., Tsay, J., Herbsleb, J., 2012. Social Coding in GitHub: Transparency and Collaboration in an Open Software Repository, in: Proceedings of the ACM 2012 Conference on Computer Supported Cooperative Work, CSCW '12. ACM, New York, NY, USA, pp. 1277–1286. doi:10.1145/2145204.2145396

Fielding, R.T., 2000. Architectural styles and the design of network-based software architectures. University of California, Irvine.

Fließ, S., 2008. Dienstleistungsmanagement: Kundenintegration gestalten und steuern. Gabler Verlag.

GitHub API v3 | GitHub Developer Guide [WWW Document], 2017. URL https://developer.github.com/v3/ (accessed 5.20.17).

Grupp, H., 1997. Messung und Erklärung des technischen Wandels – Grundzüge einer empirischen Innovationsökonomik. Springer Verlag, Berlin Heidelberg.

Haß, H.-J., 1983. Die Messung des technischen Fortschritts. München.

Homepage | Mendeley [WWW Document], 2017. URL https://www.mendeley.com/ (accessed 6.12.17).

Hot Questions - Stack Exchange [WWW Document], 2017. URL https://stackexchange.com/ (accessed 5.21.17).

Jennex, M.E., Olfman, L., 2010. A model of knowledge management success. ME Jennex Smolnik Eds Strateg. Knowl. Manag. Success Explor. Organ. Effic. IGI Glob. 14–31.

Jennex, M.E., Smolnik, S., Croasdell, D., 2016. The Search for Knowledge Management Success, in: 2016 49th Hawaii International Conference on System Sciences (HICSS). Presented at the 2016 49th Hawaii International Conference on System Sciences (HICSS), pp. 4202–4211. doi:10.1109/HICSS.2016.521

Lave, J., Wenger, E., 1991. Situated Learning: Legitimate Peripheral Participation. Cambridge University Press.

Manlio Del Giudice, P., Vincenzo Maggioni, P., Ma, Z., Huang, Y., Wu, J., Dong, W., Qi, L., 2014. What matters for knowledge sharing in collectivistic cultures? Empirical evidence from China. J. Knowl. Manag. 18, 1004–1019.

netvision, 2017. Home [WWW Document]. RAGE. URL http://rageproject.eu/ (accessed 6.11.17).

Nonaka, I., Takeuchi, H., 1995. The Knowledge-Creating Company: How Japanese Companies Create the Dynamics of Innovation. Oxford University Press.

OAuth 2.0 — OAuth [WWW Document], 2017. URL https://oauth.net/2/ (accessed 5.30.17).

Open Archives Initiative Protocol for Metadata Harvesting [WWW Document], 2017. URL http://www.openarchives.org/pmh/ (accessed 6.10.17).

OpenID Foundation website, 2017.

Osterwalder, A., Pigneur, Y., 2011. Business Model Generation: Ein Handbuch für Visionäre, Spielveränderer und Herausforderer, 1st ed. Campus Verlag, Frankfurt New York.

Paukert, M., Niederée, C., Hemmje, M., 2011. Knowledge in Innovation Processes, in: Encyclopedia of Knowledge Management.

Polson, P.G., Lewis, C., Rieman, J., Wharton, C., 1992. Cognitive walkthroughs: a method for theory-based evaluation of user interfaces. Int. J. Man-Mach. Stud. 36, 741–773. doi:10.1016/0020-7373(92)90039-N

Posnett, D., Warburg, E., Devanbu, P., Filkov, V., 2012. Mining Stack Exchange: Expertise Is Evident from Initial Contributions, in: 2012 International Conference on Social Informatics. Presented at the 2012 International Conference on Social Informatics, pp. 199–204. doi:10.1109/SocialInformatics.2012.67

Salman, M., Fuchs, M., Vu, B., Heutelbeck, D., Hemmje, M., Becker, J., Brocks, H., Research Institute for Telecommunication And Cooperation, 2016. Integrating Scientific Publication into an Applied Gaming Ecosystem, in: Annual International Conference on Computer Games Multimedia & Allied Technologies, CGAT 2016. Presented at the CGAT Conference, Global Science & Technology Forum (GSTF), Singapore. doi:10.5176/2251-1679_CGAT16.9

Salman, M., Heutelbeck, D., Hemmje, M., 2015. Towards Social Network Support for an Applied Gaming Ecosystem, in: Proceedings of the 9th European Conference on Games Based Learning ECGBL 2015. Presented at the The 9th European Conference on Games Based Learning ECGBL 2015, Steinkjer, Norway, pp. 721–728.

SlideShare.net [WWW Document], 2017. . www.slideshare.net. URL https://www.slideshare.net (accessed 6.12.17).

Specht, G., Beckmann, C., Amelingmeyer, J., 2002. F&E-Management. Schäffer-Poeschel-Verlag, Stuttgart.

Stack Exchange API [WWW Document], 2017. URL http://api.stackexchange.com/ (accessed 6.8.17).

Stack Overflow [WWW Document], 2017. URL https://stackoverflow.com/ (accessed 5.19.17).

Travis CI - Test and Deploy Your Code with Confidence [WWW Document], 2017. URL https://travis-ci.org/ (accessed 6.10.17).

Web Hooks / FrontPage [WWW Document], 2017. URL https://webhooks.pbworks.com/w/page/13385124/FrontPage (accessed 6.11.17).

Welcome To UML Web Site! [WWW Document], 2017. URL http://www.uml.org/ (accessed 6.13.17).

Wenger, E., 2011. Communities of practice: A brief introduction.

Wiederhold, G., 1992. Mediators in the architecture of future information systems. Computer 25, 38–49. doi:10.1109/2.121508