Use of Open Source Software in Health Care Delivery – Results of a Qualitative Field Study

Contribution of the EFMI LIFOSS Working Group

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Summary

Objectives: To assess and analyze the attitude of health IT executives towards the utilization of specialized medical Open Source software (OSS) in Germany's and other European countries' health care delivery.

Methods: After an initial literature review a field study was carried out based on semi-structured expert interviews. Eight German and 11 other European health IT executives were surveyed. The results were qualitatively analyzed using the grounded theory approach. Identified concepts were reviewed using SWOT analysis.

Results: In total, 13 strengths, 11 weaknesses, 3 opportunities, and 8 threats of the utilization of OSS in a clinical setting could be identified. Additionally, closely related aspects like general software procurement criteria, the overall attitude of health IT executives, users, and management towards OSS and its current and future use could as well be assessed.

Conclusions: Medical OSS is rarely used in health care delivery. In order to capitalize the unique advantages of OSS in a clinical setting, complex requirements need to be addressed. Shortcomings of OSS describe an attractive breeding ground for new commercial offerings and services that need yet to be seen.

Keywords

Open source, software, qualitative survey, health care delivery, health information technology, free software

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1 Introduction

Whilst Open Source Software (OSS) is well-established and widely adopted in other fields of application like the World Wide Web [1] or biomedical research [2], it appears to be still in its infancy regarding its utilization in clinical practice in Europe. Nowadays nearly every clinical workflow is based on or assisted by software. To rapidly and substantially advance this technology has become a major goal of the cooperate strategy of hospitals [3, 4] in order to address today's challenges in health care. OSS principles of which the free software [5] and open source [6] movements have laid the base could be well suited and offer adequate means to sustainably accomplish this mission by joining forces and collaboratively developing commonly used software technologies for health care delivery [7].

So far, advantages and disadvantages of OSS have primarily been discussed quite generally [8] without or only by slightly taking the specific aspects of health care [9] and the requirements of a clinical environment into account. In order to gain knowledge beyond theoretical considerations this field study has been carried out to explore and summarize the clinical point of view. As interview partners IT executives of larger hospitals in Germany and other European countries were selected. The main reason for this choice was the fact that they could provide the most authentic insights from a practical point of view. They are the key persons in charge of procurement, implementation, and management of software at their respective institutions and so their experiences and opinions reveal crucial aspects towards the adoption of OSS in a clinical setting.

Two similar approaches have already been attested in literature.

In a journal paper Paré et al [10] presented the barriers to OSS adoption in Quebec's health care organizations. They revealed main barriers on the basis of 15 expert interviews that were carried out with CIOs working at health care institution in the province of Quebec, Canada and correlated these to references in literature. In his master thesis Hohenwarter [11] carried out a market analysis of OSS in the Austrian health care sector. He performed 5 expert interviews to empirically verify and refine his hypothetical SWOT analysis.

Both publications revealed significant and important findings but only on specific subjects of our overall research objectives and were limited to certain smaller geographical regions. A comparison to their results will be given in the discussion.

2 Definition and Objectives

Open Source software (OSS) is understood in our context as defined by the Open Source Initiative [6]. The terms "clinical routine/setting" and "health care delivery" are synonymously used and refer to the area of application in which the software is used and denote all workflows within a health care institution that are directly related to patient care and treatment whilst excluding administrative processes or research.

The general subject of our survey is professional software or supporting components that are licensed under an OSS license and have been specifically designed for health care de-

livery like Electronic Medical Record (EMR) systems or Picture Archiving and Communication Systems (PACS). In contrast for example GNU/Linux, LibreOffice, Mozilla Firefox and the Apache Web Server are excluded from this definition as they are general purpose software.

The main objective of our study was to assess the attitude of health IT executives towards the utilization of dedicated medical OSS in a clinical setting.

In order to grasp the overall picture, the goal was also to highlight additional aspects aside from the pure advantages and disadvantages. As such the procurement criteria are seen as important as they, influenced by personal preferences and institutional requirements, affect the adoption of any type of software. Furthermore the assessment of current and future use of OSS and the attitude of clinicians and the hospital board who define the organizational context of the IT executives' work complete the overall picture.

The focus was set on qualitative analysis in favor of getting a detailed and unbiased insight of the health IT executives' experiences and opinions whilst accepting that if at all only minor quantitative information could be revealed from the data.

The purpose of this article is to present the results of a high-level qualitative analysis in a descriptive and non-interpretive manner. Thereby space is left for further research carried out on basis of our results whereas a convenient and comprehensive picture of the attitude of health IT executives can be given.

3 Methods

A literature review was carried out to identify similar and related work. Relevant publications by Paré et al [10] and Hohenwarter [11] identified by this review were examined in respect to methods, results, and scope. Their work was used as a starting point for the design of this study.

The performed field study was based on the methodology of semi-structured expert interviews [12] to fully accomplish the given objectives. The underlying interview guideline (see appendix) contained 15 open, non-suggestive questions and was discussed and agreed upon within the scientific research teams of the authors.

Two groups were examined, one to represent the German perspective and the other

one to summarize the perspective within other European countries. Interview candidates were named by the third author who acted as a consultant and health IT expert during this study. Inclusion criterion was that the interviewee was or still is an IT executive working at a larger hospital. Interviewees were contacted and if possible questioned during meetings of their professional societies. Confidentiality was assured to them in order to offer them a maximum of freedom to express their personal opinion [13]. The German group was contacted during the ALKRZ¹ -meeting in Frankfurt on the Main, Germany in October 2011. Interviews were conducted in German. Due to time constraints only two interviews were carried out in person on site and six more were followed via telephone. The second group representing other European countries was contacted during the HIMSS² CIO Summit in Geneva, Switzerland in November 2011. Eleven interviews were conducted in person on site of the meeting in English. The interview length within the two groups is illustrated in figure 1.

Interviews were recorded on tape. The resulting recordings were transcribed electronically. Transcripts were pseudonymized in order to preserve confidentiality. The qualitative analysis of the transcribed interviews was based on the grounded theory approach and the methodology as defined by Corbin et al [13] and Charmaz [14]. Concepts were derived from the transcripts and directly modeled using the mind mapping tool FreeMind [15]. Through the process of theoretical sampling and iteratively analyzing the transcripts, lower-level concepts were refined and categorized into higher-level concepts.

Identified advantages and disadvantages of OSS were regrouped in strengths, opportunities, weaknesses, and threats and additionally categorized by causality based on internal or external factors. The center of reference was chosen to be the utilization of OSS in health care. This segmentation is borrowed from the strengths, weaknesses, opportunities, and threats (SWOT) analysis method for strategic planning [16]. Besides providing a more differentiated

view it was also chosen in order to allow correlation of our findings to the results of the analysis of Hohenwarter [11].

In order to be able to provide also some quantitative information, the number of respondents that referred to a specific high-level concept will be given in round brackets using the following notation: (*DE: number of German respondents of in total eight / EU: number of European respondents of in total 11*). Listed concepts are ranked by this number. Similar concepts or topical areas to which some interviewees referred to as positive and others as negative aspects are marked with an asterisk.

4 Results

Subsequently, key characteristics of our field study will be given followed by an overview of the general attitude of the interview partners towards OSS before actually going into the identified concepts.

4.1 General Characteristics of Respondents

Within the German group all 8 interview partners are currently working as health IT executives at German university hospitals.

Within the European group 10 out of the 11 respondents are currently working as health IT executives. One used to work in that role before. Five are employed at university hospitals, 2 at larger public hospitals and 3 are acting on a regional or national level. Interviewees have been from Belgium, Denmark, England, Finland, Scotland, Spain, Sweden, and Switzerland.

4.2 General Attitude towards OSS

During the interviews, respondents were asked if they were in general advocates or opponents of OSS. The majority of respondents stated that they were in favor of OSS. Only one in each group was dismissive. Details are shown in figure 2.

When being asked about the attitude of their users like physicians and nurses towards OSS, interviewees assumed that they do not care at all about the actual software license. For them it is only important that their re-

¹ ALKRZ is the professional society of CIOs of German university hospitals, German organization

² Healthcare Information and Management Systems Society (HIMSS), international organization

quirements are fulfilled and that the software can be adapted to their workflows and needs. Furthermore users do not like changes and want to work with the software they are used to. If new software is actually introduced it must be better than existing systems.

When being asked about the attitude of the hospital boards towards OSS, respondents assumed that they would be neutral in general and leave the responsibility to their IT

department. Some stated that the board might prefer OSS because of expected cost savings.

4.3 Current and Future Use

OSS currently being used in hospitals is pure general purpose software like GNU/Linux as server operating system, various web-based content management systems (CMS), collaboration platforms, project management systems,

IT management systems, in-house developed subsystems or components that are based on common OSS libraries. OsiriX [17] is the only dedicated medical software that is known to be utilized by some users in two hospitals, but independently of the centralized IT management. Very few interviewees are considering medical OSS for future use, only Mirth [18] as integration platform was mentioned twice.

Reasons for that are manifold and may already be found in criteria expressed by interviewees as being relevant in the procurement of any type of software for their institutions.

4.4 Software Procurement Criteria

Naturally the software needs to adequately fulfill the functional requirements derived from its intended area of use. Aside from that respondents have referred to the following criteria:

Integration capabilities (DE: 5, EU: 7) - It shall be possible to integrate the software in the existing software infrastructure. Standardized interfaces shall be supported.

Costs (DE: 6, EU: 3) - Costs in general, specifically in form of price, post implementation costs, and overall costs are relevant. To relate these to the offered functionality, the cost-performance ratio is analyzed.

Continuity and sustainability (DE: 5, EU: 3) - Long-term maintenance, continuous development, and servicing shall be provided. Long-term was defined as 5-10 years by one German interviewee. It is considered crucial as underlying requirements change over time and must be addressed by regular software updates. A replacement of a software before this period shall be avoided as it involves that stored data must be migrated and that all users need to be trained on the new software.

Functionality (DE: 3, EU: 3) - Beside the fulfillment of the specified functionality the software shall leverage the underlying general clinical and support processes.

Operational availability (DE: 4, EU: 2) - Operational availability shall be guaranteed in terms of stability, reliability and robustness.

Software Architecture (DE: 5, EU: 0) - Software architecture and utilized technology shall be compatible with the institutional hardware and software environment and shall enable its deployment on existing infrastructure. The software shall offer a modular architecture so that specific functionality

Fig. 1 Distribution of interview durations in the German (n=8) and European (n=11) group

Fig. 2 Attitude of IT executives towards Open Source software

may also be provided by existing or newly introduced software components.

Trust (DE: 2, EU: 2) - The vendor shall be renowned and established on the market shown by a significant number of reference customers that are already using the software. The company shall be trustworthy also in terms of size, number of developers, and its service concepts.

Support (DE: 2, EU: 1) - The support and maintenance shall be provided and assured by the software vendor.

Ease of use (DE: 0, EU: 2) - The software shall provide a maximum of ease of use thereby assuring the productivity and efficiency of the actual work it is supporting.

No disruption of or side effects on existing systems (DE: 2, EU: 0) - New software shall not disrupt nor have any side effects on existing systems.

Performance (DE: 2, EU: 0) - The software shall offer an adequate level of performance and responsiveness.

Clinical content (DE: 0, EU: 1) - The software shall support established clinical workflows and be able to handle the clinical content adequately.

Conformity to legal regulations (DE: 1, EU: 0) - The software shall conform to legal regulations.

Documentation (DE: 1, EU: 0) - The software shall be well documented.

After questioning respondents about general software procurement criteria, advantages, and disadvantages specific to OSS, the results were assessed and modeled as strengths, weaknesses, opportunities, and threats. An overview of the concepts found is shown in figure 3.

4.5 Strengths

Price (DE: 5, EU: 5)* - The actual price of the software is seen as a strength due to the absence of licensing costs.

Collaborative development (DE: 2, EU: 6) - Within an OSS community, software can be developed and extended although one's own resources are limited or insufficient ("crowd sourcing"). Furthermore the opportunities to openly share knowledge, code and to participate in the process of building them are seen to be of high value.

* Similar concepts or topical areas to which some interviewees referred to as positive aspects and others as negative aspects.

Fig. 3 Overview of strengths, weaknesses, opportunities and threats

Flexibility (DE: 3, EU: 3) - According to interviewees, OSS offers more flexibility as the code and application programming interface (API) are available and can be adjusted to one's needs.

Independence (DE: 1, EU: 4) - Respondents stated that by the utilization of OSS proprietary interfaces and dependence on the software vendors ("vendor lock-in") can be avoided.

Market-oriented development (DE: 3, EU: 1) - OSS is mainly developed by users for users, so to speak from a clinician's point of view and fulfill their requirements very well. As a result user demands are addressed in a more flexible way and sooner than in proprietary software.

Continuity (DE: 1, EU: 1)* - Interviewees expected that in case an OSS is prevalent on the market it will normally continue to be developed and maintained for at least about a decade. In case it is discontinued, it still can be adopted by a hospital or an assigned third party due to its license terms.

Functionality (DE: 2, EU: 0)* - The functionality of OSS is seen by respondents to be good and at the same level as proprietary software.

Openness (DE: 1, EU: 1) - IT executives valued the openness of the source code that facilitates the understanding of how the software works and the ability to directly communicate with the developers via the respective community's mailing lists.

Performance (DE: 0, EU: 2) - Respondents highlighted performance as one of the strengths of OSS.

Support (DE: 1, EU: 1)* - The level of support that is provided by larger communities is seen as an advantage in respect to response time and quality although it is non-guaranteed due to its voluntary provision.

Development times/release cycles (DE: 1, EU: 0)* - OSS projects are considered to have acceptable release cycles and developments times.

Range of products (DE: 0, EU: 1)* - Variety of available OSS is seen as a strength.

Stability (DE: 0, EU: 1)* - Stability in terms of robustness is highlighted as a positive aspect of the OSS.

4.6 Weaknesses

Lack of support (DE: 6, EU: 6)* - A major weakness is seen in the lack of guaranteed support that may be required 24 hours a day, 7 days a week and 365 days a year. Interviewees thus saw the need to rely on professional service providers or to build an in-house support on their own.

Lack of liability and accountability (DE: 4, EU: 6) - The non-existence of liability and accountability is also seen as a major shortcoming. As the software is provided without any warranty and development occurred on a voluntarily basis there is no contractual obligation regard-

ing the fulfillment of advertised functionality and the continuous onward development. A respondent expressed that trust is required in coincidence for a required feature to be implemented, meaning that one has little influence on and guarantee of what features are actually implemented by the project community. Another interviewee was doubting that one could rely on the work of a loose community to support the core business of the hospital.

*Limited range of products and offered functionality** (DE: 2, EU: 3) - According to respondents there is not much OSS available that offers the full range of functionality typical to core software systems used within a hospital like clinical data management systems, EMR systems, and PACS. Offered functionality is limited and lacks maturity. Another one stated that there is very little decent OSS available that is commercial grade for health care delivery.

Advanced skills required (DE: 1, EU: 3) - IT executives felt that the in-house maintenance and development of OSS requires their employees to have advanced skills in software engineering. Aside from the challenge to actually find qualified people, one is then dependent on those colleagues and may lose significant knowledge in case they leave. A respondent summarized that to effectively utilize OSS it is required not only to have access to the source code, but also to be able to understand and work with the code.

*Costs** (DE: 0, EU: 4) - Interviewees were afraid of additional costs that naturally arise when support and development of OSS is done in-house. Furthermore the utilization of OSS is thought to induce organizational changes that result in follow-up costs for its implementation, management and training.

Lack of integration capabilities (DE: 2, EU: 1) - A weakness of OSS is that it lacks integration capabilities and that data formats are not compatible with existing software systems. An interviewee emphasized for example that OSS does not have tools nor interfaces to centrally manage the software.

Labor-intensive (DE: 0, EU: 3) - Respondents considered the utilization of OSS to be labor-intensive as all steps have to be done by the hospital itself. Although this aspect is closely related to costs, interviewees explicitly highlighted the extra amount of work that is required to cope with OSS.

Lack of marketing (DE: 2, EU: 1) - OSS projects are seen to not have any kind of marketing that takes care of the trust in and the standing of the project in regards to its community. One respondent put it in that way that marketing is not part of the original idea of OSS.

*Insufficient stability** (DE: 1, EU: 1) - The stability of OSS is considered to be insufficient.

*Undefined development times and release cycles** (DE: 1, EU: 0) - Interviewees stated that the development times and release cycles of OSS are not defined and tend to be irregular.

Inferior GUI (DE: 0, EU: 1) - The GUI of OSS is felt to not be on the same level as proprietary products.

4.7 Opportunities

Dissatisfaction with proprietary vendors (DE: 4, EU: 5) - The biggest opportunity for OSS appears to be the dissatisfaction of health IT executives with proprietary products and its vendors. Respondents stated that they felt dependent on vendors because they have to follow their product strategies, are not able to influence its development, and cannot customize it to their needs. The advancement of proprietary products is felt to be cumbersome and not very innovative. Other interviewees stated that the big companies need to shrink and that their "utopian prices" need to be lowered to an acceptable level. In their eyes OSS could be the counter pole facilitating this change.

*Power of the community** (DE: 2, EU: 0) - The people within an OSS community are said to be enthusiastic, committed, and professional and that they form by their community based collaboration virtual teams that are in numbers larger and better working than software development departments of proprietary software vendors.

New business model for hospitals (DE: 0, EU: 1) - The use of OSS may enable a new business model for hospitals' IT departments. After adopting OSS in their own institution they can sell the thereby gained knowledge and expertise in form of services like training, customization, or deployment to other hospitals.

4.8 Threats

Legal regulations (DE: 6, EU: 5) - Legal regulations that apply to any type of software

that is used in a clinical setting are seen as a major issue. Not only the conformity to laws and the required certification but also the continuous adjustment to new and revised legal requirements are seen as a serious threat for the utilization of OSS in health care.

*Community-based development** (DE: 0, EU: 4) - The community-based development process appears to be unpredictable and tends to be too slow or too fast in releasing new versions. Either one has to wait or to retrain users every time a new version is released. Furthermore respondents do not concede OSS communities to build complex systems and consider them to be better at developing specific components of a modular overall system. In general the governance of an OSS project is seen to be unclear in respect to ownership, control, evolution, and replication of the software.

Specialty of the Health IT (DE: 0, EU: 4) - The health IT market itself is very fragmented and has requirements that are unique in terms of scope, complexity, and specialization. Furthermore there exist only a comparatively little number of professionals in this domain that are familiar with these unique requirements. Thus the number of potential candidates to form or to get involved in a respective OSS community is very limited compared to more general areas of application like for example OSS-based Web technology.

Obscure Open Source market (DE: 0, EU: 2) - OSS that is available on the market is according to respondents hard to find. Furthermore it appears to be difficult to evaluate an OSS project on a well-informed base.

Conservative nature of software vendors (DE: 1, EU: 1) - According to interviewees vendors of proprietary software hinder the implementation of OSS. For example they do not allow integration of OSS to their products and by that are preventing new OSS to be adopted in the existing infrastructure of the respective institution.

Patents (DE: 1, EU: 1) - Patents are seen in general as a threat although one respondent mentioned that the actual key business point is not the software itself but the process that it changes.

Trust in vendors (DE: 1, EU: 1) - IT executives trust established vendors of proprietary software more as their brand appears to guarantee the maturity and continuity of their products.

Commercial interests (DE: 0, EU: 1) - Respondents are afraid that commercial interests

may arise as soon as an OSS project gets popular and widespread. A commercialization may lead to abandoning the original OSS and transforming it into a proprietary product.

5 Discussion

5.1 Discussion of Methods

The method of a semi-structured expert interview has proven to be effective in providing much freedom to follow the interviewees' stream of consciousness thereby obtaining the desired unbiased picture of their personal attitudes. Still by referring to the interview guideline it could be assured that all relevant aspects of the overall research objectives have been covered. The designed guideline itself was adequate and was not revised during the interviews.

The mind-mapping software Freemind [15] is convenient for modeling a small number of concepts. In our work the identified number was relatively high so that the refinement, identification of duplicates and cross-referencing appeared to be quite a challenge at the end. In the future professional CAQDAS³-tools should be preferred.

While interviewing, the interviewer was pressed for time in most cases as the respondents were quite busy and needed to hurry to their next talk or appointment. A time frame of an hour would have been the ideal choice to be able to clarify concepts and to allow more detailed inquiries. Nevertheless theoretical saturation [13] could be achieved in both groups. The scope and depth of the gathered data were sufficient to draw a clear and pristine picture of the IT executives' attitudes.

5.2 Discussion of Findings

The results of our study allow a broad and detailed insight into fundamental concepts to the utilization of OSS in clinical routine in Germany and other European countries. Major concepts cited by about half of the overall respondents are

- Lower or non-existing price (seen as strength)

- Capabilities offered by collaborative development (seen as strength)
- Lack of professional support (seen as weakness)
- Lack of liability and accountability (seen as weakness)
- Dissatisfaction with proprietary vendors (seen as opportunity)
- Conformity to continuously changing legal regulations (seen as threat)

The first four aspects are probably covered in most essays about OSS and are as such no new findings aside the fact that also health IT executives are aware of them. In contrast dissatisfaction with existing vendors seems to be more specific to the health care domain and is backed up for example by a satisfaction survey of practitioners and clinicians in Germany undertaken by the bvitg⁴ [19]. Strict, complex, and ever-changing legal regulations are very specific to health care. Important to note is that respondents not only referred to medical device regulations but to country or even federal state specific legislation that define for example also the documentation scope of medical records and the coding systems to be used. Regulations might even change on an annual base and deployed software systems are required to implement resulting changes in time.

Many aspects elaborated by Hohenwarter [11] and Paré [10] et al correlate to our findings, although some have been described in a slightly or fully different notion.

According to Hohenwarter "cost" is constituted as strength, which does not fully match with our findings. Respondents have seen the lack of license costs (*price*) as positive although additional *costs* for in-house development and support are seen as weakness. He describes "quality" as strength although it was not referenced as such by our respondents and may correspond to the concepts of *performance* and *stability*. The strengths of "interoperability" and "ergonomics" identified by Hohenwarter are contrarily represented in our results as interviewees have seen a *lack of integration capabilities* and an *inferior GUI* of OSS. Further strengths of "innovation potential" and "security" could not be identified in

our study. As weaknesses Hohenwarter has highlighted "guarantee" and "governance" which are in line with our concepts of *lack of liability and community-based development*. The third weakness "certification" is part of our more general concept of *legal regulations*. The opportunities of "cost-cutting measures", "demographic changes", "new markets" and "new technologies" described by Hohenwarter have not been referenced by our respondents. "New business segments" is closely related to *new business model for hospitals*, although our concept describes just one segment of these. The threats "lack of lobbying", "tightening of medical device law" and "no community" are closely related and inline to *lack of marketing, legal regulations and community-base development*. "Rival businesses" and "rival proprietary technologies" have not been expressed by our interviewees.

Most of the barriers to the adoption of OSS revealed by Paré et al correspond to our results. The "lack of internal IT resources and expertise" is represented in the concepts *labor-intensive* and *advanced skills required*. The described "lack of reliable information about open source products" clearly relates to *obscure OSS market*. The disadvantages *lack of support and lack of liability and accountability* are referred to by Paré's barrier "lack of responsible third party". A hint to the barrier "conservative nature of health care CIOs" may give the by respondents stated procurement criteria *trust* as they want to rely only on established and commonly used products. "Hidden costs of open source products" are in line with *costs* in our results. "Internal and external political pressure" has not been identified as such in our study but is partially similar to our concept *conservative nature of software vendors*. Only Paré's barrier "individualistic and competitive culture" has not been constituted by our interviewees.

The qualitative design of the study and its sample size are considered not to be sufficient to also allow a quantitative analysis or an interpretation of the regional differences between Germany and other European countries.

A limitation of our study is certainly the inclusion of health IT executives operating at larger health care institutions like university hospitals. For this reason our findings are only generalizable to a specific extent. Regional hospitals or general practitioners

³ Computer Assisted/Aided Qualitative Data Analysis (CAQDAS)

⁴ German Federal Association of the Health IT industry („Bundesverband Gesundheits-IT, bvitg e.V.")

probably have different technical and organizational requirements. However we expect that the scope and number of identified concepts would be quite similar and that only the quantification of specific aspects might differ.

To summarize, aside from the stated limitations, a detailed and comprehensive insight of the use of OSS in German and other European health care delivery systems could be given thus successfully achieving the defined objectives of our study.

6 Conclusions

As stated also by an interviewee, the primary question is not whether to prefer OSS or proprietary software. It is about the offered functionality and fulfillment of the organizational and domain specific requirements. Only then one is able to exploit the particular benefits and freedoms that are offered by OSS licenses and its underlying principles.

Our study has demonstrated significant aspects that could be capitalized by companies to offer customized products and services that address especially the identified shortcomings. Thereby a working ecosystem for the health care domain could be established like it is prospering already since years in the areas of GNU/Linux or Web technology. It remains to be seen if OSS has the potential to accomplish the requirements in respect to user satisfaction and efficient and effective workflow support. At least the number and variety of available dedicated medical OSS - more than 285 projects that are known to the authors [20] – form a well-founded base to finally progress the adoption of OSS in health care delivery.

Future studies may add to a quantification of the elaborated concepts and compare also different groups and perspectives like larger versus smaller institutions or regional differences.

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Conflicts of Interest

The primary author is vice-chairman of the IMIA Open Source working group, creator of the Medfloss.org information portal and asso-

ciate member of the Free Software Foundation. The secondary and third authors are members of the board of the Open eHealth Foundation.

Appendix

Interview Guideline

1. Which criteria of a software product in general are most important to you in the procurement process?
2. What are the strengths of Open Source?
3. What are the weaknesses of Open Source?
4. Would you denoted yourself more like an opponent or advocate of Open Source?
5. What do you think about how widely Open Source is used in health care? What are the reasons for that?
6. Are you currently using Open Source at your institution?
7. Are you planning to deploy Open Source in the near future?
8. Did users or colleagues demand for the introduction/usage of a specific Open Source software?
9. Are you aware of any users that are using Open Source independently of the central IT management?
10. From your point of view, what are the most important criteria that need to be addressed by Open Source software so that it will be introduced in your institution?
11. From your point of view, what are the major barriers that are preventing the utilization of Open Source in health care and especially in your institution?
12. Assuming that you would have the choice between a proprietary and an Open Source solution that are equal in respect to costs and functionality, what would you choose? What are the reasons for your decision?
13. Would you support/participate in or even initiate an Open Source project? What would be the motivation for your involvement?
14. What do you think is the attitude of the board/management of your institution? And what about the general opinion of the users?

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