Design Methods for Complex Architectures

DEMCA

Existing system development methods are insufficient to deal with the radically increased complexity stemming from increased scale, interdependencies, and types of ICT solutions. There is therefore an urgent need for a new system development paradigm. DEMCA will contribute to the development of the core elements of this paradigm: Design processes, architecture principles and governance approaches.

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1. Vision and Objective: A New Paradigm for Complex Information Systems

Contemporary Information and Communication Technology (ICT) solutions are increasingly interdependent and large scale i.e. complex. ICTs are no longer developed and managed as stand-alone and monolithic systems, but are built and implemented as parts of a larger whole. This change is particularly prominent in the domain of healthcare. As an example, the development and introduction of a new electronic patient record system at a hospital has to be aligned with existing work practices of doctors and nurses, with other existing clinical information systems (both electronic and paper based), and with patient administrative systems, laboratory information systems and imaging systems. The new system will be subject to both national and international standards for privacy regulation, message exchange and health indicator reporting. Thus, the new patient record becomes one small piece in a large architecture of information systems, medical devices, standards, governance structures, practices and users that together support patient handling and treatment. While systems developers may use existing systems development methods to develop the patient record component, aligning with and becoming a part of the larger “infrastructure” is a different challenge. This challenge is not about decomposing complicated requirements and deriving optimal technical designs, but grappling with the complexity that emerges from the heterogeneity of systems, actors involved, and the lack of control over other systems and components – in brief, the challenges are associated with a complex architecture.

This complexity poses a challenge to existing theoretical and methodological perspectives in informatics, since “the reductionism behind today’s software engineering methods breaks down in the face of systems complexity” (Sommerville et al., 2012, p.71). Existing system development and software engineering methods, including state-of-the-art agile and user-centred methods as well as advanced programming tools and frameworks all seek to cope with the challenge of dealing with complexity. But most of them are software-centric and fail to address the heterogeneity of large scale, complex information systems. Such challenges are “unlikely to be addressed adequately by incremental research within established categories ... [but] ... require breakthrough research.” (Northrop et al., 2006, p. xi). We therefore need new conceptions of the nature of such systems and new approaches to design, develop, govern, monitor and assess them. In short, our vision is to develop a new system development paradigm. This paradigm must be founded on a theoretical understanding of complexity, to help design and govern large scale, and complex information systems.

The Global Infrastructures (GI) research group has over the last two decades worked towards developing a design-oriented “information infrastructure” theory, which has helped to shift the focus from standalone systems to large scale, complex information systems – or what we coin information infrastructures. Being centred on understanding and handling the complexity of information infrastructures, this theory has significant value academically, and practically for system developers and policy makers, and it has gained international acclaim within the Information Systems (IS) community with e.g. five research articles published since 2004 in MIS Quarterly. We believe this theory has the potential to be one core element in the required ‘paradigm change’ in system development methods. However, this theory needs further development, as well as further work on operationalizing it and producing more concrete system development methods. We define system development methods to include concepts, principles, taxonomies, models, frameworks, guidelines, and best practices, and in this document the term methods will refer to this broad range of outputs.

The GI research group is grounded in interpretively-informed, action-oriented research in the healthcare sector in developing countries, and multiple longitudinal studies in the healthcare sector in Norway. Our major empirical domain is healthcare, a complex and information-intensive sector undergoing major transformations that have significant impact on the use of ICT-based clinical, administrative and managerial systems. Thus, the healthcare sector is a highly relevant arena for research into the generic challenges emerging from the growing complexity of ICT solutions. For example, in Norway there are initiatives to redesign core aspects of the sector’s information infrastructure, e.g. to establish a national Care Summary Record to overcome the fragmentation of patient information being located in multiple disconnected systems. As another example, India has developed integrated systems to track every pregnancy and child birth in the country. Such initiatives encounter complexity in the form of multiple types of data, high volumes of information, technical
heterogeneity of systems, a wide diversity of use and users, a politicized context where donors and governmental politics play a significant role, and a dynamic situation of rapid rate of change. Large scale, complex IS are implicated in a maze of legal, administrative and technical regulatory mechanisms, such as standards, professional norms and laws. Decision making within such a context needs to accommodate overlapping and perhaps conflicting interests of multiple stakeholders.

DEMCA will leverage on the empirical research in the Global Infrastructures research group to advance methods targeted to the development of large scale, complex information systems.

Within this empirical context (both in the Norwegian health sector and in developing countries) the DEMCA initiative and the involved PhD-students will conduct targeted research with the following objectives:

1. **Develop methods**: The PhD-students will contribute to the development of system development methods for large scale, complex information systems. We will continue our work on the theme of *design processes* and build up a stronger focus on *architecture* and *governance*. The PhD students will work with these themes and have a particular focus on the operationalization of the new paradigm with methods to develop and manage large scale, complex information systems.

2. **Develop methods in the field**: Within DEMCA, our objective is to conduct the required empirical research to test theories in the field, to produce methods that help us to practically deal with the complexity. We will do this with a basis in the opportunities offered by GI’s unique, real-world, and global research laboratory for conducting action-design research which has been on-going for two decades, centred on open-source-based health information infrastructures within the public health domain of various developing countries (called HISP). Similarly, we will draw on our established research in the Norwegian healthcare sector at department, hospital, regional and national level. Our objective is to leverage on the potential for mutual synergies between these two empirical domains in terms of developing new system development methods.

3. **Strengthen the linkages between research and teaching**: The PhD students will bring methods that emerge from their action research into the teaching. This is new in the GI group, since we primarily have students with 3 year projects. We will evaluate, redesign and develop the current curriculum and courses offered by the GI group (bachelor, IFI-master, EVU-master and PhD), and contribute to make these methods part of other relevant courses and programmes at IFI. For example, students could already in the beginner courses (INF1000 and INF1050) be exposed to examples of large scale, complex information systems with related system development challenges and possible strategies and approaches.

4. **Strengthen the GI research group**: DEMCA will contribute to other on-going activities aimed at strengthening the GI-group’s role as a central actor in the international network establishing this new paradigm (including research, teaching, innovation and conveying knowledge to the society at large) and to prepare us for the next round of SFF.

### 2. Evolutionary processes, architectural principles and governance models

Through the last two decades, the GI group has sought to bring forward aspects of socio-technical complexity and to articulate shortcomings of traditional system development methods, through the empirically based articulation of information infrastructure theory (e.g. Hanseth and Lyttinen 2010). Ours and others’ research have demonstrated the high technological, organizational, cultural and political heterogeneity of information systems (IS) and their interdependencies. Key outcomes of this research are concepts that capture central aspects of information infrastructures, such as seeing them as open, shared, standardized, heterogeneous, evolving installed bases. Studies have shown that large scale, complex IS are not designed from scratch; they emerge through incremental processes where learning and innovation is central, as a solution that serves an increasing scope and number of users, and when individual solutions are integrated, modified and extended through gateways (Monteiro 1998). They evolve, hence ‘design’ means to govern their evolution in specific directions (Hanseth
The research has illuminated the central and non-trivial nature of standardization (Monteiro and Hanseth 1995) and the dilemmas associated with both building on and departing from the pre-existing installed base which could potentially lead to lock-in situations (Katz and Shapiro 1985). Also other fundamental dilemmas have been identified, such as the need to balance between standardization of technology and work practices on the one hand, and the need for flexibility to accommodate different and continuously evolving user needs on the other hand (Rolland and Monteiro, 2002). The GI group has sought to understand the nature of the evolutionary processes, both through longitudinal case studies in the Norwegian health sector (e.g. a two decades’ long cooperation with the IT department at Rikshospitalet), and through action-research of building healthcare information infrastructure within the Health Information Systems Program (HISP), which has had significant impact on the ground. Based on such studies, the research has contributed to re-conceptualize development processes as “installed base cultivation” (see e.g. Ciborra et al. 2000). The research has emphasized the central role of transition strategies (as opposed to strategies oriented towards goal formulation only) and strategies that are sensitive to the existing technological and institutional possibilities and constraints. Evolutionary design approaches requires an approach where scalability (technical and institutional) is inherent from the beginning rather than as an afterthought. Summing up, the previous research in the GI-group has been focused on how information infrastructures evolve and has aimed to derive methods for planning and managing evolutionary design processes (e.g. Braa et al. 2004; Braa et al. 2007). There are still unresolved issues within the domain of evolutionary processes. One important remaining challenge is how to scale up end-user involvement in system development. Relating to the Scandinavian tradition of participatory design, which has required local, incremental development, how can we deal with the setting of on-going development for multiple contexts on a global scale?

In addition to the central research theme of evolutionary processes, the research in DEMCA will pursue two emerging themes: the large-scale, complex solutions’ architectures and the regulatory control mechanisms put in place around them. First, there is an urgent need for a research focus on architecture. The importance of architectures is evident in industry trends towards componentization, modularization, and service orientation of enterprise architectures. At the same time, it is an underdeveloped theme in academic research, in particular as relates to broader sector-wide architectures. For instance, e-health architectures are becoming increasingly complex and diverse in the health sector in both the Northern and Southern hemispheres. The challenges of managing and synchronizing these architectures increase exponentially, arising from the multiplicity of heterogeneous systems, platforms and technologies, their multi-level nature (e.g. state, national, global), systems having simultaneous memberships in multiple or inter-sectorial architectures (a system belonging both to an e-health and e-governance architecture), and new emerging configurations of “architecture of architectures” (such as linking of hospital-based and primary health architectures) (Sahay et al. 2009). Adaptive development approaches require the design of alternative architectures, instead of traditional integrated, monolithic solutions (Braa and Sahay 2012). Contemporary research has not kept pace with these transitions, and new methods are needed. The group’s actual empirical engagement with these evolving architectures – a process we denote with the verb “to architect” – in the health sector in both Southern and Northern hemispheres represents a huge opportunity to further our research and develop foundational knowledge for enabling the paradigm shift. The theme of architecture represents the core thrust of this initiative. We pursue key dimensions of architectures through studies of: a) central clinical systems in the Norwegian health care system on regional and national level, b) emerging architectures for patient centred care, c) the challenges associated with cloud architectures for health care systems in developing country contexts, d) various models for national e-health architectures, and e) emerging architectures for personalized medicine (utilizing genetic information). An interesting possibility is to study whether and how the DHIS 2 (the open source software system developed and used within the HISP network1) can be used within the Norwegian context. For instance, we are currently running a prototype implementation project with Folkehelseinstituttet in Norway, implementing an antenatal care registry based on DHIS 2 functionality which has emerged from the context of primary healthcare in developing countries.

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1 For more information about HISP and DHIS 2, see for example hisp.uio.no or dhis2.org
Second, we need to strengthen the research focus on the variety of governance structures that significantly impact the trajectories of large scale, complex IS. While the evolutionary design theme deals with how the development process is organized in time and space, the governance theme relates to the way decision making structures around the development activities are organized. Current IT governance methods (e.g. Sambamurthy and Zmud 1999; Weill and Ross 2004) build on the assumption of control within a closed-system paradigm. Large scale, complex IS in contrast are implicated in a maze of legal, administrative and technical regulatory mechanisms, such as standards, professional norms and laws. Decision making (or governance) within such a context needs to accommodate overlapping and perhaps conflicting interests of multiple stakeholders across recursively nested structures spanning multiple levels. It is not obvious what constitutes an appropriate scale or “locus” of decision making in such as setting, e.g. what to standardize and how strongly to standardize, or how to section a large scale, complex IS into governable entities. Several large scale e-health projects in the Norwegian sector have struggled or failed due to inadequate handling of the involved complexity. A targeted study of the variety of approaches and their associated pros and cons, would yield a useful taxonomy or typology of governance models for large scale complex systems, equivalent to what exist for information systems. Appropriate approaches for governing large scale, complex IS are also perceived as an urgent theme within the context of HISP as a globally distributed, on-going, and agile development project. There is a huge need to develop and implement concrete approaches that can help to deal with the tensions between requirements emerging from multiple local (i.e. country-level) implementation sites with the priorities and needs of the global core software development team, concretely on designing a governance structure of centralization and/or distribution of resources, roles, mandates etc. in the development and implementation of DHIS 2. Ongoing research in the GI group focuses on developing software engineering methods for distributed and agile development of global software platforms such as the DHIS 2, particularly enabling the incorporation and dissemination of local innovations. Novel trends, such as the introduction of cloud technologies in developing countries, and the general trend towards introducing patient-based information systems in public health, also pose urgent and important questions related to appropriate legal and regulatory governance mechanisms for large scale, complex systems. Moreover, novel technologies challenge traditional approaches to regulation, for instance, the Norwegian populations’ demand for and uptake of globally available personal health applications on mobile, cloud-based platforms or the trend towards personalized medicine may require revisions of today’s legal regulation of technologies.

DEMCA is expected to have a significant impact in terms of academic and methodological outputs. The proposed empirical research address core areas and further the operationalization of insights into large scale, complex IS, which will contribute to meet a demand for new system development methods. Such methods comes with the potential to have broad economic and societal implications as they will lead to less failure and increased durability of large scale, complex IS projects broadly, with resulting cost benefits and improvements to the wellbeing of all in society. DEMCA will also have direct, practical relevance for health workers and authorities in several developing countries, and the involved PhD-students will facilitate sustained impact on global health challenges such as maternal and infant mortality and HIV/AIDS by improving the use of health information for local action.

2.1 Research and organizational milestones

The project will be organized on the basis of three research themes: i) evolutionary processes (1 PhD); ii) governance (2 PhD) and, iii) architecture (5 PhD). A professor from the group will be designated to each of them; Eric Monteiro (Process), Petter Nielsen (Architecture), Margunn Annestad (Governance) and Ole Hanseth will have a particular responsibility for working across the themes2. The project will be managed by Margunn Annestad, together with those responsible for the themes. To assure high quality, the managers will meet every quarter and more frequently if necessary. The responsible for each theme will follow the progress of the activities and report to the project manager.

The PhD-students will be actively recruited within our research network, assuring high quality

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2 We have already started with this topical approach with a batch of Master students on governance in 2012 and currently recruiting a batch focusing on architectural themes
candidates as well as strengthening the ties between our partnering institutions. They will also actively participate in empirical research and theory and method development activities such as workshops, seminars, conferences, joint writing and a book-project. As a part of their teaching obligation (the 4th year), they will further participate in the evaluation of our curriculum related to methods, interact with other research groups, and take part in the redesign of courses and programmes. Key activities and milestones are listed in table 1 below.

<table>
<thead>
<tr>
<th>Activities</th>
<th>Timing</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Develop the paradigm</td>
<td>2014 – 2020</td>
<td>Further develop our basket of method for the new paradigm</td>
</tr>
<tr>
<td>Improve curriculum</td>
<td>2014-2020</td>
<td>Evaluate and update the curriculum in the GI group</td>
</tr>
<tr>
<td>Introduce new course</td>
<td>2015</td>
<td>Initiate Master course on architecture</td>
</tr>
<tr>
<td>III conference by GI</td>
<td>2015</td>
<td>Innovations in Information Infrastructures conference</td>
</tr>
<tr>
<td>Book</td>
<td>2016</td>
<td>Book project related to the III conference, co-authored with researchers in the network</td>
</tr>
</tbody>
</table>

Table 1 Project Plan

A list over possible PhD research topics and empirical domains are listed in table 2 below.

<table>
<thead>
<tr>
<th>Theme</th>
<th>Research topic</th>
<th>Empirical domain</th>
</tr>
</thead>
<tbody>
<tr>
<td>Evolutionary</td>
<td>Reconceptualising participatory design in large scale, complex IS</td>
<td>Organization of end-user participation in DHIS 2 implementation projects. Output: Practical guidelines</td>
</tr>
<tr>
<td>Architecture</td>
<td>Transformations of existing e-health architectures</td>
<td>Consolidation of fragmented systems portfolios (Helse SørØst) and design of national solutions. Output: Guidelines for consolidation and migration processes</td>
</tr>
<tr>
<td>Architecture</td>
<td>Transformations of existing e-health architectures</td>
<td>The impact of cloud architecture and of mobile reporting channels on e-health architectures in DHIS 2 sites. Output: Guidelines for design</td>
</tr>
<tr>
<td>Architecture</td>
<td>Developing novel types of e-health architectures</td>
<td>Emergence of patient-centred architectures, and/or architectures for personalized medicine. Output: Principles for evolutionary architecting</td>
</tr>
<tr>
<td>Architecture</td>
<td>Inter-sectorial architectures built on 'core components'</td>
<td>Civil Registration and Vital Statistics (CRVS) as cross-sector, foundational, multi-purpose core component. Output: Understanding requirements to 'core components'</td>
</tr>
<tr>
<td>Architecture</td>
<td>Assessment of the implications of various architectural models</td>
<td>Comparing centralized, federated and decentralized architectures. Output: evaluation methods</td>
</tr>
<tr>
<td>Governance</td>
<td>Appropriate mechanisms of governance of large scale, complex IS</td>
<td>Cross-case study of how large scale, complex IS are governed. Output: taxonomy of governance models</td>
</tr>
<tr>
<td>Governance</td>
<td>Governance of globally distributed agile software development</td>
<td>Assess models of distribution of mandates, decisions rights, and resources within DHIS 2. Output: guidelines</td>
</tr>
<tr>
<td>Governance</td>
<td>Emerging regulatory aspects of patient based architecture</td>
<td>Issues relating to privacy of patient data in less regulated developing country context. Output: guidelines for evolutionary approaches to regulation</td>
</tr>
</tbody>
</table>

Table 2 Possible research themes and cases

2.2 The project in a national and international context

As pointed out in the reviews from the final round of last year’s SFF, the GI research group is uniquely positioned globally to capitalise on the combination of a deep, longitudinal and action-design oriented involvement with healthcare with a strong academic record (high-quality publications, PhD production) of conceptualising complex information infrastructures. Based on this fundamental, we are well positioned to generate and promote the identified paradigm shift by developing theory and methods. Members of the group have been central in the development of Information Infrastructure theory, with publications in top-tier information systems journals (e.g. five research articles published since 2004 in MIS Quarterly, ISI-impact factor 4.659 (2012)). Open-source software developed within the group, the District Health Information Systems (DHIS 2) – under the flagship research initiative HISP, constitute key elements of the health information
infrastructure ecosystem rallied around DHIS 2 in more than 30 African and Asian countries, including multiple states in India. Through use in multiple contexts, DHIS 2 is gradually becoming a global standard, and is described by an external evaluation study commissioned by NORAD\(^3\) and also by a Lancet article as “the biggest implementation of open-source health information systems [in the world]” (Webster 2011). The DHIS 2 has been facilitating processes of local innovation, contributing to broader development trajectories in various user countries. DHIS 2 and HISP received University of Oslo’s innovation prize in 2013.

There are research groups working on the new paradigm in other parts of the world, in particular the UK and the US. Rather than competing with these groups, we have had a long standing collaboration with them, materializing as joint projects\(^4\), joint writing (e.g. Hanseth and Lytyinen 2010), and joint supervision and jointly arranging conferences\(^5\). There are also small and independent research communities at the other Norwegian Universities and Colleges with PhD-students working on related issues, which are invited to and meet in our workshops and seminars (e.g. the biannual PhD-days).

3. The research group

The group is currently staffed with 10 faculty members, 7 postdocs, 34 PhD students, as well as 3 fulltime programmers, 1 implementation coordinator, and 1 community manager who are working with HISP/DHIS 2. The number of PhD students might seem high, as many are recruited from the Quota programme (currently 13). The throughput is also high, and since 2006, 28 PhD students have graduated from our group and 7 more will defend their theses in 2013. The GI group has pursued mutually reinforcing agendas of contributing academically towards theory development in parallel with empirical studies in the Norwegian healthcare context as well as action-oriented, policy-relevant establishment of large scale, complex IS in the domain of health care in developing countries. This combination of academic excellence with close-to-practice activities constitutes a prime strength of the group. With a core competence in informatics, the GI group has leveraged an international network of multidisciplinary competencies ranging from public and medical health, social sciences, and globalization, to development studies. A well-established, strong and international PhD programme provides the engine to support this research progress.

3.1 Synergies and added value from DEMCA

The resources in DEMCA will work in concert with the resources obtained after the SFF process in 2012, and also the other on-going research and scholarship (e.g. Quota) programmes. Together, these resources will make it possible to generate significant research results in close collaboration with a network of top international scholars enabled through the SFF. This will act as an excellent platform for PhD-students to engage with the larger community and for them to establish their own researcher networks.

The central value added by DEMCA is the potential to draw on empirical insights and conceptualizations to bring new insights required to operationalize the new system development paradigm. This initiative enables the GI group to build upon the accumulated base of knowledge on which existing research rests, with more targeted empirical studies. In the context of the wider group activities, these insights will be subject to further synthesis and integrative analysis and finally operationalization into actionable system development methods. With DEMCA, the GI group will be able to:

- Continue the work on the theme of design processes, increase our activities in governance and establish a strong focus on architecture. This will directly promote the development of a broader and more encompassing basket of methods
- A more explicit focus on operationalizing our empirical insights and conceptualizations to become relevant system development methods
- Strengthen the cross-domain (Norway and developing countries) synergies in the GI group by

\(^3\) The Health Information Systems Programme, Final evaluation report submitted to Norwegian Agency for Development Cooperation by PATH

\(^4\) E.g. China EU Information Technology Standards Research Partnership involving University of Edinburgh

\(^5\) E.g. The Innovation in Information Infrastructures conference will be arranged by the GI group in 2015
collectively developing design methods

- A critical and continuous evaluation of the curriculum in the GI group in light of the methods
- Engage in making the new methods reflected in the curriculum at IFI more broadly, and thereby prepare our students to manage large scale and complex IS

3.2 Organizing and robustness of DEMCA

This application is developed by a well-established research community, the GI research group, and will involve its national and international network of collaborating researchers, which constitute the strongest research community on large scale, complex IS worldwide. With our global scale of activities within the health care sector in Norway and various Asian and African countries, we offer a unique setting for research where design methods can be developed, tested and refined. The PhD projects will take advantage of and be a part of the environment where researchers from both international and national institutions and research groups are brought together. This happens within our established institutions of PhD-days (a doctoral consortium we have arranged biannually since 2001) and Research-days, around presentations and discussions of work in progress in the GI group and its wider network. This network will serve as a site for researcher training and for cross-fertilization of ideas and development of publications through mutual exchange and collaborative writing.

4. Researcher and management training

The GI-group has developed an extensive and well-structured PhD programme. This includes the “upgrade milestone” after one year\(^6\), a “trial defence” before submitting the final thesis plus the biannual “PhD Days”. The “PhD Days” have attracted PhD students from other Norwegian Universities (NTNU, Tromsø, Agder, and BI), as well as from abroad (LSE and University of Cambridge), and has in that way served as a national PhD School.

4.1 Recruitment and research plans

Our aim is to use substantial efforts to recruit the best PhD candidates. We build on a strong track-record with 35 graduated PhD students in 7 years (2006 – (end of) 2013). We have a long term and predictable recruitment plan, which involves in part, bringing in new candidates in batches. We believe this approach will add predictability when we are trying to recruit our own (IFI) top Master students. We also have the opportunity to recruit from the high number of potential candidates within our own ‘Design, Use and Interaction’ Master programme, the most popular programme at IFI. This strategy takes into account the challenge we find in recruiting good candidates for PhD positions in Informatics, as we are in strong competition with the industry (e.g. related to salaries). To increase our chances to get the right candidates, we will: 1) Spend significant time on specifying the requirements to the candidates’ competencies, experiences, ambitions etc., 2) identify where we can recruit such candidates, 3) ensure that we announce vacant position in the right channels, 4) actively use our network nationally and internationally both in academia and the industry and public sector to identify and recruit candidates, and 5) implement a rigorous evaluation process mandating elaborate project proposals, evaluation of academic work, letters of recommendation and interviews. The recruitment process will be initiated early January 2014 and proceed as described in table 2 below. The student activities will be distributed over the period 2014-2020 (table 3), with a peak in the activities in 2017.

<table>
<thead>
<tr>
<th>Activities</th>
<th>Timing</th>
<th>Students and themes</th>
</tr>
</thead>
<tbody>
<tr>
<td>M1.1 Batch #1 recruited</td>
<td>01.04.2014</td>
<td>2 PhD-students on architecture</td>
</tr>
<tr>
<td>M1.2 Batch #2 recruited</td>
<td>01.04.2015</td>
<td>1 PhD-student on process + 1 on governance</td>
</tr>
<tr>
<td>M1.3 Batch #3 recruited</td>
<td>01.04.2016</td>
<td>1 PhD-student on architecture + 1 on governance</td>
</tr>
<tr>
<td>M1.4 Batch #4 recruited</td>
<td>01.04.2017</td>
<td>2 PhD-students on architecture</td>
</tr>
</tbody>
</table>

Table 3 Recruitment plan

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\(^6\) Introduced some years ago, this is now institutionalized as the ‘3rd semester report’ at The Faculty of Mathematics and Natural Sciences
The PhD-students recruited will follow the ‘conventional’ PhD-research plan in the GI-group and be a part of our ‘research school’. Table 4 below describes the typical PhD-project, where the focal point will be to play a part in an ethnographic study of a large scale and complex case, commonly including an action-oriented component where the PhD-students actively take part in a development and implementation process. With the focus on strengthening the new paradigm and making it a part of the curriculum at IFI, the teaching obligations of the PhD-students will be focused on contributing to improve our existing courses on both Bachelor and Master level (e.g. INF3290, INF5210, INF5890) as well as develop a new course on architecture of large scale information systems. They will also take part in evaluating the curriculum at IFI and develop course material to support the new paradigm more broadly at IFI and in the beginner’s courses in particular (e.g. INF1000 and INF1050).

<table>
<thead>
<tr>
<th>Year</th>
<th>Main activities</th>
<th>Cross-cutting activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Courses and empirical research</td>
<td>- Bimannual PhD-workshops and research days</td>
</tr>
<tr>
<td>2</td>
<td>Courses and empirical research</td>
<td>- Master supervision</td>
</tr>
<tr>
<td>3</td>
<td>Empirical research and teaching</td>
<td>- Literature review</td>
</tr>
<tr>
<td>4</td>
<td>Teaching and writing up thesis</td>
<td>- Paper writing</td>
</tr>
</tbody>
</table>

Table 4 Research Plan

Should the available resources be less than stipulated, we will narrow our scope to a focus on architecture, leaving out the theme of process and governance. The students will then follow the same study plan and we will recruit one PhD-student per year in the period 2014 - 2017.

4.2 Aims for training research managers

The senior GI group members have extensive experience leading projects in academia with partners in Asia and Africa and the industry. To strengthen the research leadership in the group we will continue to promote the junior members (post docs and associate professors) by assigning them project management responsibilities and key roles in PhD supervision. Our aim is also that at least three of the group members (seniors and juniors) will participate in the Research Leadership Programme at the University of Oslo (RLP) in the period 2014 – 2015. The purpose of this is to develop stronger project management skills and a strengthening of the quality of our PhD-student supervision.

5. Funding

5.1 Funding from other sources

DEMCA builds on and extends almost two decades of research. This has created a significant impact both in terms of academic output and practical relevance to health workers and authorities in several

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7 Supporting the University of Oslo’s strategy to share knowledge and improve its dialogue with the society-at-large, the PhD-students will actively participate in public debates and communicate research results in mass media
countries globally. Currently the GI group’s activities are supported by four research grants from the Norwegian Research Council’s Verdikt programme (in total about 11 MNOK in 2013) and 15 MNOK from a joint donor initiative (NORAD, Global Fund and PEPFAR) in 2014. In addition we have received 3MNOK (1MNOK/year over 3 years) as a “loosing SFF finalist.”

5.2 Experiences from NFR and EU

Societal challenges within health is a core thematic focus of Horizon2020, the new EU Framework Programme for Research and Innovation, which encourages cross-disciplinary approaches and specifically seek to stimulate innovation and market uptake of research outputs. These are characteristics of our work, implying that the framework should offer opportunities to draw on our international network to build relevant consortia for applications within this framework. Health, welfare and ICT are also central themes in the current Norwegian research strategy\(^8\). We have had numerous projects from the NFR and also expect future opportunities for project funding.

6. Other issues

6.1 Gender balance

The GI group is well placed to promote gender equality. First, both the leader of the GI research group and the leader of DEMCA are female. Currently, the GI group has 32% female PhD students (11 females out of 34 PhD students in total), 32% of the PhD graduates have been female (9 out of 28 since 2006), 29% (2 out of 7) of Postdocs are female and 20% (2 of 10) professors are female. Two of the five professors in the management group of GI are female, showing high compliance with University of Oslo’s strategy towards gender equality (cf. “Strategy 2020” and its associated Gender Equality Action Plans). Our existing organizational culture and working and learning environment is conducive to women, and will be further strengthened through DEMCA. We will attempt to assign one female supervisor to each female PhD student, and will strive to recruit female candidates. This will be done through actively encouraging female applicants to vacant positions, and by establishing moderate gender quotas. Our goal is that 45% of the PhD students, Postdocs and researchers in the GI group will be women.

6.2 ELSA/HMS

GI researchers must agree to comply with the standards for ethical conduct of research required by both Norwegian law and that of the countries and institutions of their fieldwork. Issues of appropriate research conduct and integrity are discussed both in research method courses, and in plenary discussions at e.g. the biannual Research Days or the PhD-days. This focus will be further strengthened through DEMCA. We aim to intervene in the domain of healthcare information systems and produce changes for the better. While introducing technology is in itself neither morally problematic nor neutral, we seek to do this in a transparent and accountable manner. In our activities we promote user participation, encourage local capacity building and seek to generate ownership. As our research methods hinge upon close collaboration with our research objects, the reliability, relevance and accountability of our research is strengthened. Visions associated with improved use of ICTs in the health sector stipulate digitization of previously paper-based information flows, reduction of transportation, and general improvement of work process efficiency. This is expected to generate significant environmental effects as well as creating societal value.

\(^8\) Meld. St. 18 (2012–2013): ”Lange linjer – kunnskap gir muligheter”. Kunnskapsdepartementet
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