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1. Introduction

ICT infrastructure and information systems have come to play a vital role in globalization. Walsham (2008) highlights three major aspects of this phenomenon: software outsourcing, virtual teams, and information system (IS) roll-out. In this paper we examine shifts over several years of globally distributed development and roll-out of an open source information system targeted at the public health care sector in developing countries, which touches on all three aspects. In following the development of an system as it co-evolved with the various institutional settings in which it was embedded, we highlight shifting sources of legitimation in institutional processes involved in health information systems implementation. The attention to changing sources of acceptance and legitimation frames our view on knowledge between local cultures and related stakeholders, in the interplay with global FOSS development.

Paraphrasing Bowker [2000], health information systems operate simultaneously at the concrete level of participatory design and implementation (fields in a database, capacity building, integration of datasets and organizational practices…) and at an abstract one (dealing with the relationships between information science, organization, public health, and global software development, among others). Therefore, social studies of science and organization have a significant contribution to make to the process of growing information systems in order to create tools for health monitoring and policy making. For this, we need to historicize our action and its organization: "it is vital to dissolve the current disjunction between database (as technical storage medium) and policy (as way of acting in the world). The production of the database is productive of the new world we are creating." [idem].

By examining the scaling of development and implementation of health information systems in developing countries, this paper aims at understanding collaborative knowledge development across heterogeneous networks of local, national and global actors, and between public health workers and free and open source software (FOSS) developers in dissimilar contexts. We introduce "PHIs" as an acronym as an amalgam of PHI (disguised acronym for Project for Health Information) and HIS (the principal software developed within the project). This hybrid acronym represents the socio-technical nature of the actor-network. PHIs began in South Africa in 1994 as health services underwent major restructuring post apartheid, aiming at standardization of

information for local action. Subsequent international expansion underscored tensions between the local and the global (Rolland and Monteiro: 2002) related to knowledge gaps and communication practices affecting roll-out and institutionalization.
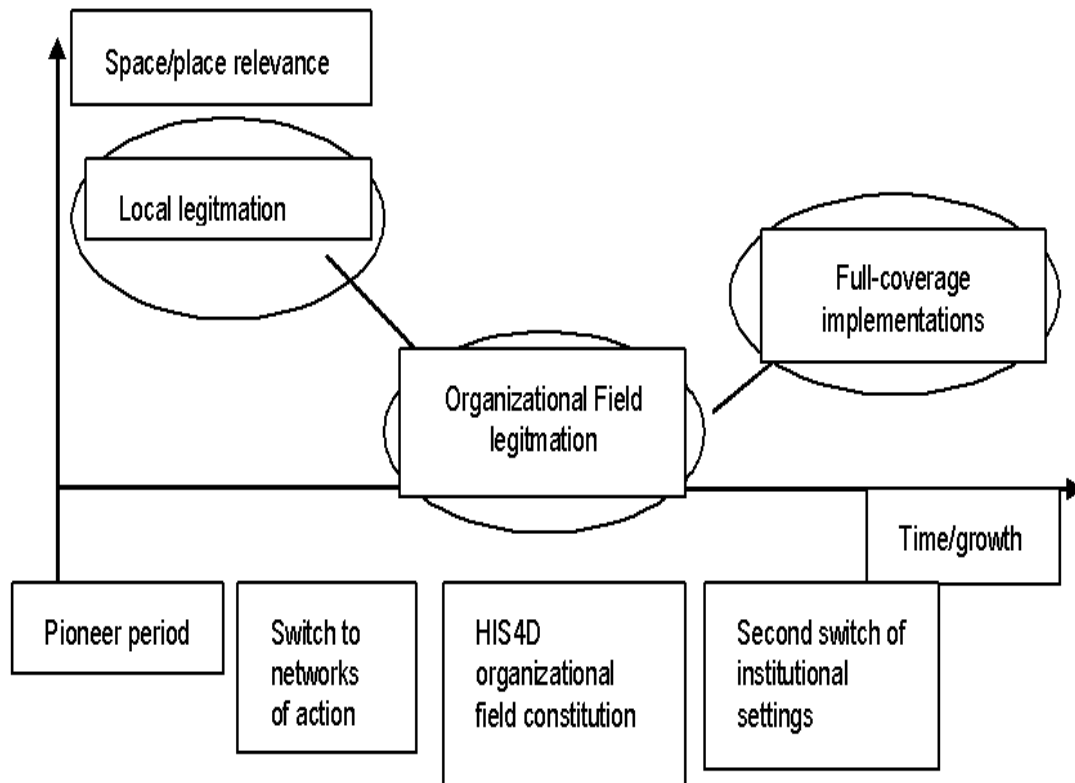
The above figure illustrates a model to interpret shifts in PHIs over time. The vertical axis indicates the intensity of relevance of specific places and local settings. The horizontal time line relates to the stages of PHIs evolution we have identified: pioneer, field constitution, and full-scale implementations, demarcated by 1) a switch of legitimation from local contexts to an organizational field, and 2) a further switch to legitimation relying on state structures.

2. First Switch: from Local Bounds to Organizational Field

PHIs engaged in bottom-up, participatory software prototyping to develop a district-based HIS with rapid iterations and a focus on flexibility (Braa and Hedberg: 2002). Legitimation at the local level was achieved by embedding the system into the organizational setting, and aligning

with the needs of staff at all levels, as well as with local educational arrangements. Such sensitivity to local organizational cultures contrasted strongly with mainstream development strategies, and in turn provided a strong foundation for successful provincial and eventually national acceptance in South Africa in 1999. We open our empirical account with a quote from an implementer who was involved in the project from the early days:

> South Africa in 1994 was at a turning point in the history of the country; a time of hope, uncertainty and potential chaos. People were both hopeful and fearful; hopeful of a more open, transparent and inclusive society, fearful of the way in which this change would happen. In the health services, major restructuring was happening across the board. Equity, redistribution and integration were central themes in the shift from a fragmented hospital based medical model to a Primary Health Care Approach driven by a nurse based community model within a district health system. New health worker cadres, managers and colleagues coupled with new services and systems created an atmosphere of chaos. Waves of consultative teams were making the rounds, asking questions about problems, but also promising sweeping reform. This was met by skepticism. Voluntary retrenchment, early retirement and 'new face' promotions were the order of the day. The users of the service were also more demanding. Health workers knew things were 'not right' and that different strategy and work practices were both required and desired. However, it seemed that there was a new way of doing the old job every other week. Everything was up for grabs; an opportunity for research by 'outsiders' who would come in, implement a new practice and leave staff with 'the mess'. Soon things would revert to the old tried and tested ways. It is into this chaotic arena that PHIS began to peddle its wares; not with the middle managers, but with health workers at facility and district levels. Would the tools, models and practices advocated by PHIS have had the same impact a decade later? It is argued that 'timing was everything'; that the period of transition provided a crucial window of opportunity for the project"

Indeed, in the apartheid years, prior to 1993, the South African health services were highly fragmented by racial categories. Also, the health system had been oriented towards hospital services, with primary health care delivery poorly developed. This legacy meant that change in

the organization of reporting became a major element in the processes of re-defining the health system after the fall of apartheid.

In addition to early experiences in Mongolia and South Africa, one of the project initiators drew upon prior experience from HIS research in Ghana, which had gone through a process of health system restructuring in towards more action-oriented information managemt, developing the idea of rationalizing information. The proposed design strategy was based on the assumption that an IS consists of much more than the technical artifact, with a focus on local level and community based Participatory Design (PD). PD approaches were seen to be of particular importance as they may function as a means for community empowerment, and possible relations between community participation and PD as practiced in the Scandinavian tradition were explicitly explored. The Scandinavian PD tradition has had a focus on the workplace. However, discussing PD in a developing country context, the focus shifts from the workplace to the community. In referring to the three rationales for using PD approaches suggested by Greenbaum and Madsen (1993); i.e. the pragmatic, the theoretical and the political perspectives, it was proposed to add the community perspective. So PHIs developed a vision "to support the development of an excellent and sustainable health information system that enables all health care workers to use their own information to improve the coverage and quality of health services within our communities", and the process towards HIS was based on local management and community structures and addressed local needs. Motivation, commitment and the creation of a sense of ownership of the system by all interested parties were deemed to be of vital importance.

Based on the experiences in pilot projects, a six step model was developed within PHIs for health information system development and implementation:

1. Local team and commitment are crucial. Get people from the community on board and find concrete activities in which they can participate
2. Situation analysis (information audit)
3. Set objectives, targets and indicators
4. Create district based information system and structures
5. Training of staff - local empowerment; i.e. focus on data needed to make local decisions to improve coverage and quality of services

6. Creating a district information culture: i.e. the information needs to be used on a regular basis, allowing the IS to be improved gradually. Analysis of data should become a daily routine aimed at improving service delivery

By the turn of the century, HIS had been officially endorsed as a national standard in South Africa, and pilot projects were commenced in several provinces; KwaZulu-Natal, Mpumalanga, Northern Cape, and the North West Province. However, the project expansion was not only a South Africa intra-country scaling process. Due to the relative success the project had experienced so far, it was believed that a similar approach and philosophy might be translated to other similar countries, and PHIs crossed the border to Mozambique. The launch of the project in Mozambique marked the beginning of what would later become a remarkable widespread geographical expansion of PHIs. The initiation of PhD and Master study programs shared between the coordinating university and partner institutions in Mozambique represented a new way of gathering resources for project implementation while strengthening local education programs. The new organizational and cultural environment meant new challenges for the PHIs approach, both theoretically and empirically; e.g. as the relative success in South Africa had in part relied on a "window of opportunity" due to a general wish for change, in other countries existing systems and entrenched interests proved significant obstacles to smooth implementation of the system.

In the case of Mozambique, PHIs started as a pilot project in three districts. A distinct difference between South Africa and Mozambique was the required sources of legitimation of the project. Although the pilot projects created local interest, lack of top-level support hindered substantial results in the highly centralized decisionmaking structures of the public sector. In addition, contrary to what had been the case in South Africa, stability was valued over change. However, learning form the Mozambican experience with limited impact from pilots in small geographical areas, it was also acknowledged in the project that without appropriate coverage, both in terms of hierarchical geographical span and in relation to the various health programs, results were hard to obtain. To deal with need for scale and coverage, the actions of PHIs were expanded from three districts to three whole provinces. Despite the formal support for this from ministry level, real change was never supported, as the initiatives of the PHIs always came as an additional burden to

the standard routines for health staff. This lack of real top-level commitment in the centralized HIS context of Mozambique meant that the project lost a lot of momentum.

In South Africa, the initially community driven, bottom-up effort became an official national standard. The South African PHIS project itself went through formalization and professionalization processes becoming a separate legal entity. In Cuba, the very concept and method of user-participation – typical of the Scandinavian approach- did not fit with the local context, thus the theoretically "context-sensitive" way of making robust systems was found to be highly incompatible with local conditions. User participation/participatory design carries a strong democratic inscription, which ran into severe obstacles within the public health hierarchy. Although the delivery of health services is decentralized in Cuba, the decision making power is not, and bottom-up approaches are seen as a threat to the political system as a whole. Health personnel proved uncomfortable with new powers, responsibility and risks of making decisions. In Ethiopia, regional successes again proved hard to translate to the national level, and the ministry decided to rely on the expertise of a local company to develop their own system (incorporating many of the same principles) of rather than relying on the open source PHIs network.

Still, over time, PHIs got acceptance in a number of countries, facing different political and organizational cultures. Its bottom-up, not-for-profit approach legitimated pilots in Malawi, Cuba, Mongolia, and India. In all cases, the expansion was afforded through the alignment of health authorities, educational institutions, research centers, and FOSS development practices (which provided affordances for such a diverse set of actors).The establishment of such relations linked local and global networks of actors, through a negotiating process which tended to be legitimized in local needs. At the same time, the formal education part of the network was significantly expanded with many new master and PhD students.

Gradually, PHIs became a globally dispersed network of small scale IS implementations (except South Africa). A perspective on action research and actor network theory is developed, with a claim that "local interventions need to be part of a larger network to be robust" and handle the twin challenges of sustainability and scalability. Working in multiple contexts provides

opportunities for cross fertilization in a network, whereas narrowing down on one best practice exposes the project to the risks of volatility, which usually characterizes the institutional environment in developing countries. The form of "Networks of Action" (Braa et al.: 2004) provided agility and cross-legitimation, but also exposed a risk of spreading too thin, and missing institutionalization. Furthermore, alliances were formed with other players active in developing countries, such as projects on medical record systems and UN organizations. The result was a switch of legitimation from local contexts to an emerging organizational field of HIS for development (HIS4D).[1]

The introduction of the HIS system could also have negative effects, and was seen by some to somewhat paradoxically divert attention from quality of care to data quality. The gradually closer influence of the organizational field and international organizations entailed a transition in emphasis from local participation to the production and use of information for broader monitoring, and also from management and quality of health care to management and quality of health information. Variables are increasingly defined on the basis of international standard requirements. If in the first period of PHIs information was tightly coupled with local contexts, the expansion of the project produced an "information space" with its autonomy and specific issues (like duplication of variables and indicators) which are not evident at the micro level. Therefore, the growth of the project itself, and of the related information sphere implied a switch from emphasis on local legitimation processes to legitimation in more global socio-technical issues (technological choices, adoption of internationally accepted standards and datasets, millennium development goals consideration, etc) embodied by international donors' requirements, which link their support to those issues.

To sum up, after the first switch from local legitimation to a more global organizational field as arena of activity, HIS began to inscribe a different context characterized by other priorities, where key players (software companies, international donors, health standards and goals) are not local, immediately perceptible from the implementation level.

3. Second Switch: from Organizational Field to Full-scale Roll-out

The challenges of scaling are usually seen as related to increasing demands in terms of workload, scope of the system, and the range of functionalities that must be supported. Such escalation of complexity in turn produces a proliferation of side-effects. Awareness of this expanded risk is

crucial and tallies well with PHIs experience. However, beyond these challenges posed, scaling up from a pilot phase to full scale roll-out also entails shifts in the institutional setting. Whereas pilots are an institutionalized way to test the capabilities of a system in real life settings, a wider roll-out is regulated by different rules and accountabilities. The involved actors must not only increase their capacity, but also learn to deal with very different institutional constraints, implying different values, orientations, and legitimated patterns of action.

A PHIs member stated: "it's very useful to use achievements on the ground to show the possibilities of the system. […] The general problem is the lack of leadership and support at international level. A lot of bottom-up activities didn't manage to get turned around on the top level." A number of recent cases within PHIs show that the bottom-up approach, which characterized the beginning of the project, is turning into a more top-down one. The South African story is still leveraged for negotiations, but local pilots do not seem to be central anymore: Having succeeded on a national level in South Africa and being tied into the organizational field globally provided the needed legitimacy for new states to consider the software, but meant less attention was given to the original philosophies propounded by the project. This aspect is quite clear in recent implementations, where local health authorities ask to shut off some of the functionalities of HIS, frequently the ones which make the system useful at local level (i.e. local data analysis). "They don't care about information for action" a PHIs action-researcher complained. Even if pilots are started to test viability in each country, the power remains at the central level. According to this, decentralization and local empowerment do not seem to determine PHIs action. A similar top-down focus was exemplified by the following comment from a key decisionmaker in an African country: "I would prefer a new system using the already accepted WHO indicators".

So, while focus gradually shifted to full-scale implementations to cover large areas like a state or a country, a re-allocation of resources was required to comply with the needs and requirements of the institutions responsible for health in those areas. Accountability was achieved by establishing national NGOs in South Africa, India and Vietnam, and contracts were entered into with national authorities and with the UN. While the ability to draw on the global network was of continuing

importance, engagement with bureaucratic structures and politics became increasingly salient. Those aspects are now empirically presented.

For years, there was a strong push from the core software developers to have regular releases instead of constantly downloading the latest version committed to the source code repository, which had then not had time to undergo extensive testing. However, the constant pressure for improvements hindered this, and it was not until the fall of 2008, after extensive field trials in Sierra Leone, that the core team felt confident enough to declare a 2.0 "final" relase (as opposed to the previous "milestones" and "beta"). For a presentation in Geneva in May 2008, a rough solution was created to demonstrate how patient data in a medical record system could be aggregated into an increasingly accepted indicator exchange format and then imported into HIS. This helped raise the legitimacy of both solutions, as part of an emerging Country Health Toolkit of interoperating components - which in itself was thought of as a response to the needs of full rollouts: In several developing countries, the PHIs project is being met with requests to also help set up patient records, and in one African country, the Minstry of the Interior wanted assistance from the Ministry of Health in coming up with a software solution for national person IDs, starting with newborns and patients visitng clinics, but gradually using the same for issuing passports, licenses etc.

In India, the transition to the national level made it possible to engage the authorities in a thorough revision of what data should be collected and used to calculate key indicators, with a focus on the PHIs "information for action"-approach, which resulted in a new consensus around a dramatic reduction in the data items collected. However, cases such as Cuba can serve as examples of local (national) settings resist change and force accomodation to different institutional forms. In one case, having five year plans in place, decisionmakers insisted on replicating a hugely cumbersome and detailled statistical information gathering apparatus, rather than using information for action.

A couple of UN initiatives indicate the necessity of appraising the big picture and scoping out an architecture able to cover most of the functions carried out by health systems, from local clinical encounters via district and provincial administrations up to natinoal and global monitoring and

evaluation efforts. One approach to this is *Enterprise Architecture* (Stansfield et al 2008).

The new organizational and cultural environment of full scale roll-outs meant new challenges for the PHIs' approach. The project is now characterized by two paths to institutionalization, one of the health information infrastructure on which PHIs is active, the other within academia. The issue of scalability is common, but the practices are not always like that. Scalability becomes an official research topic in the heading research group. This is how it is spelled out in a manifesto draft:

> We take a broader view on information infrastructures to include both the technical components such as the technologies and standards, and also the interconnected social and organizational elements such as work practices, human resource issues, politics, and other institutional conditions. […] key research issues of the group:
> - Scalability, or how to generate and manage growth
> - The tension between standardization and flexibility;
> - How can global work processes and infrastructures be controlled (or managed) (e.g. practical as well as legal, regulatory and institutional systems around OSS issues)
> - What kind of risks are involved (produced);
> - How can learning and innovation take place and be supported and taken into account within global work processes and infrastructure development;
> - How are information infrastructures different in the context of "third world" countries, and what different approaches and strategies are required for their cultivation to support socio-economic growth processes
> - How are information infrastructures (or: how can information infrastructures be) maintained, sustained and institutionalised?
> - And first of all: The interaction between these.

More on the action side of this action-research effort, in 2006 one of the Indian team members said during a focus group that she was surprised by the short period it took in South Africa to gain the momentum for exponential growth. Although it can be misleading to compare post-apartheid South Africa and contemporary India, such differences raised a question among PHIs

members and in university corridors: "can it be that the chances to bootstrap and establish an infrastructure depended so heavily on historical contingencies and causalities?"

In India, the presence of powerful software entities, both public and private combined with a strongly hierarchical tradition, to make it hard to pursue a bottom-up approach. For example in Gujarat, while the local team was putting its efforts in the health facilities, an agreement of the state health department with a national public company stopped the activities for a while. A conference about information technologies for development provided an opportunity to discuss with a broad audience of researchers and practitioners: one of the issues pinpointed was that the Gujarat's stop may have marked a crisis of the PHIs bottom-up approach to HIS development and implementation. If so, it is important to understand why top-down agreements coexist to bottom-up rhetoric (one of the sparking questions of this submission). Our interpretation is that the HIS4D organizational field has become much more crowded, and this necessitates situating the project in relation to a number of new actors, moving and affecting considerably more resources. Negotiations tend to be at state level, and this is where the balance between different approaches has to be explicitly and tacitly negotiated.

The case of Kerala, a Southern state of India, is of particular interest both because of a strong tradition of self-reliance and independence from global and Indian trends (which made the organizational field less crucial in comparison to local considerations), and PHIs use of FOSS (which facilitated alignment with official state policy). Indeed, the Government of Kerala officially writes:

> ICT has opened up the possibility of radically different information exchange patterns by facilitating faster and more efficient dissemination of information. It can play a vital role in sustaining the democratic ethos of the Indian society and ensuring a high level of transparency and accountability in governance […] The Government has a comprehensive view of ICT as a vehicle for transforming Kerala into a knowledge-based, economically vibrant, democratic and inclusive society. By the term "inclusive," the Government means that the benefits of the socioeconomic transformation possible through ICT should reach every single citizen of the State. This policy document defines the Government's vision, mission and strategy for achieving the same. […] The Government's vision is to turn

Kerala into a knowledge society with sustainable economic growth, social harmony and high quality of life for all. The Government realizes that Free Software presents a unique opportunity in building a truly egalitarian knowledge society. The Government will take all efforts to develop Free Software and Free Knowledge and shall encourage and mandate the appropriate use of Free Software in all ICT initiatives.

Kerala policy identifies a meso-level between global trends and local specificity, which is crucial in situating full coverage implementations of HIS. Indeed, FOSS technologies are what make PHIs an acceptable vector of ICT-based transformation because they promise inclusion and democratic development. Practically, the software is expected to be more under control of the local authorities and developers' team. Both philosophically and practically, the Kerala government maintains that FOSS can be used to enact cooperation and communal property, which is more consistent to its own ideological dispositions and long term development strategies.

The table below summarizes the second shift in software and organizational characteristics:

Networks of action	Full coverage roll-out
bottom-up	top-down
centrifugal expansion	centripetal focus
agility	stable capacity
open communication	internal discussion
global scope and functionality	national and local customization
spreading thin	consolidation
selection of favorable conditions for success of pilots	capacity to cope with the variety of situations that the state presents
occasional competition between pilots	one system (up-front competition for tender)
loosely structured	formal organizations

4. Discussion

The notion of "counter networks" (Mosse and Sahay 2003) draws upon Castells' (1996) argument that social development in the context of globalization is related to the use of ICT and determined by the ability to establish synergistic interaction between technological innovation and human values. Central in this connection is communication between "nodes" in a network. Marginalized groups may counter their exclusion through the creation of such counter networks. This is the line that PHIs explicitly follows, focusing on education, research, improvement of communication practices both inside the health care hierarchy and with the population in general.

The opening figure illustrates the fluctuating relevance of local legitimation: in the fledgling period, it is crucial. As the influence of the organizational field strengthens, global trends become most influential. Finally, state-wide implementations again require an emphasis on specific conditions, though differently from in the pilot stage. Commonly, the challenges of scaling ICT implementations are seen as related to escalation of complexity in terms of workload, functions, and scope, combining to trigger proliferation of side-effects and risk. In parallel to this view, we highlight the qualitative switch between regulatory contexts, on top of the quantitative growth of a system. Shifting relations to local institutions (organizational culture, public authorities, politics etc) means that scalability requires actors to be able to relate to quite different cultures, accountabilities and communicative practices. More empirically from our case, we can see how the accepted scope shifted from local health facilities needs in post-apartheid South Africa (when the aim was of integrating health systems for different races by integrating information flows for local action), to the identification of common problems and converging resources from a variety of settings. Such networks of action supported the expansion of the project. But interlinked pilots needed another kind of institutional legitimation to expand. So to avoid the risk of spreading thin, state decision makers had to be involved to allow and support broader implementations. At that point, information requirements from health systems were more rooted in basic routines, rather than experimental implementations. In the second switch, from the networks of action to full, centrally sanctioned roll-outs, the requirements were qualitatively different. To roll out, there is an expectation of something more robust and smoother. The software must be intuitive and user friendly, capable of handling large datasets, professional quality manuals must exist, and extensive training conducted (at one extreme, training involved 24 000 people in Kerala). Such

changes explain the adoption process by linking it to the socio-technical capacity of matching diverse institutional settings. Looking at the oscillation between different sources of legitimation, we can understand how the transformative role of ICT (Avgerou, 2007) actually played out in the different phases of the scaling. The qualitative shifts between phases counteract a linear conception of ICT diffusion.

We can note a re-positioning of PHIs strategy: the approach has indeed been steered more towards top-down than from the original bottom-up, which shifted from the community and health facility to the ministries of health level. It is claimed within the network that still pilots are organized at district level. This is surely characterizing PHIs approach to localization of its interventions. Nevertheless, it has to be acknowledged that local appropriation and empowerment of health personnel is currently not the driving force of adoption as it was in South Africa. "Cultivation" is still an important element of PHIs action, but capacity building and incremental change are not pursued directly at the district or community level, but at rather at the ministerial level in most infrastructural hubs. Consequently, the 'seeds' are different: graduate programs, health information coverage of wide regions, relations between public administrators and internationally active organizations, the constitution of software developer teams, etc.

In this sense, efforts to establish a health information infrastructure can be seen as institution building activities, changing according to available sources of legitimation.

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[1] Following a Neoinstitutional view, Organizational field denotes the frame of reference of organizations engaged in a specific activity, their interactions constituting a recognized area of activity.