CENTRES OF EXCELLENCE AND RELEVANCE: THE CONTEXTUALISATION OF GLOBAL MODELS

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Summary

This paper analyses how the global model of centres of excellence and relevance (CERs) is adopted and adapted in three countries, Indonesia, Malaysia and the Netherlands. Each of these three countries have to some extent embraced the discourse of the knowledge society and knowledge economy in their higher education and science policies and have – in their own ways – promoted the development of strategic research and the establishment of centres of excellence and relevance. It is the objective of this paper to explore the ways these global models become embedded in the national institutional context and what factors explain the different paths in which the three centres of excellence and relevance have evolved.

INTRODUCTION

The discourse of the knowledge economy and knowledge society is apparent in higher education and science policies throughout the world. Universities need to become more responsive to social and economic needs of the emerging knowledge societies and economies. Education and research are assessed on the basis of their external relevance, not just on the basis of internal disciplinary requirements. For research, this has led to increased emphasis on university-industry linkages, academic entrepreneurship and the emergence of strategic research. One organisational embodiment of these trends is the emergence of centres for excellence and relevance where new ways of conducting science materialise and where the embedding in society plays an important role (Rip, 2002). This paper analyses how this global model of a centre of excellence and relevance (CER) is adopted and adapted in three countries, one lower middle income country, one higher middle income country and one high income country (World Bank classification), respectively Indonesia, Malaysia and the Netherlands. Each of these three countries have to some extent embraced the discourse of the knowledge society and knowledge economy in their higher education and science policies and have – in their own ways – promoted the development of strategic research and the establishment of centers of excellence and relevance. It is the objective of this paper to explore the ways these global models become embedded in the national institutional context and what factors explain the different paths in which the three centres of excellence and relevance have evolved. The study analyses three of such centres in detail: the Pusat Penelitian Bioteknologi (Biotechnology Research Center, PPBiotek) at the Institut Teknologi Bandung (Bandung Institute of Technology, ITB) in Indonesia, the Institute for Research in Molecular Medicine (Informm) at the Universiti Sains Malaysia (Science University Malaysia, USM) and Biomade (Bio-Organic Materials and Devices) of the Rijksuniversiteit Groningen (University of Groningen, RuG) in the Netherlands. Before analysing the global models and explaining the local variations, the paper will start with a closer look at centres of excellence and relevance and relate them to the changing nature of the university in the contemporary knowledge economy and knowledge society.

GLOBAL MODEL AND LOCAL CONTEXT

The concept of the ivory tower as a symbol of the university in the nineteenth and twentieth century gradually became substituted for the concept of the university as a fuzzy, blurry arena whit a plurality of actors and interests. This new university model is now described and prescribed under different terms like the innovative university (Clark, 1996) or the entrepreneurial university (Clark, 1998), the enterprise university (Marginson & Considine, 2000), the post-modern university (Rip, 2004), the service university (Buchbinder, 1993, Tjeldvoll, 1997, Cummings, 1998), the stakeholder university (Jongbloed & Goedegebuure, 2001), the responsive university (Tierney, 1998) et cetera. The contemporary university is a mishmash of these perspectives on the role of the university and can best be described by the terms openness, relevance and responsiveness. The contemporary research university is a culmination of these new models, where universities need to become more innovative and entrepreneurial, act more like an enterprise, have to incorporate the interests of a wide range of stakeholders, sometimes engaging in alliances with them, and need to be responsive to these stakeholders. In short, it will become more oriented towards serving society and economy. While independent production and dissemination of scientific knowledge was the trademark of the ivory tower model of a research university (Tjeldvoll, 1998), the production and dissemination of scientific and professional knowledge (excellent as well as relevant), as a service to society and economy, is the trademark of the service model of the research university.

The creation of new knowledge and the transfer of this knowledge as a service to the wider society and economy is a key issue in the new model of the service oriented research university. In the transition towards a knowledge economy and knowledge society, universities need to produce more knowledge, relevant knowledge and also become responsible for the transfer of that knowledge to those parties that need it. The transformation in knowledge production and transfer has been approached from different viewpoints and received different labels. Most widespread is undoubtedly the Mode 2 thesis by Gibbons and his colleagues (Gibbons, et al., 1994; Nowotny et al., 2001). Mode 2 knowledge is produced in the context of application characterized by a problem-solving approach to specific issues, as opposed to a context governed largely by the interests of an academic community. The old paradigm of scientific discovery was characterized by the hegemony of theoretical or experimental science; by an internally-driven taxonomy of disciplines; and by the autonomy of scientists and their host institutions, the universities. This paradigm was being superseded by a new paradigm of knowledge production which was socially distributed, application-oriented, trans-disciplinary, and subject to multiple accountabilities. For a university the shift implies a profound change in the way things are done. One can expect new research domains to arise. These new domains rely on a multiplicity of disciplines for their fundamental knowledge and focus on the most promising fields of application, like information technology, biomedical research or nanotechnology. This type of research is not equivalent to applied research, but takes the form of strategic research. Strategic research is basic research carried out with the expectation that it will produce a broad base of knowledge likely to form the background to the solution of recognized current or future practical problems (Irvine and Martin, 1984). An important organisational indicator of the increasing importance of strategic research is the spread of centres of research excellence and relevance (Rip, 2004: 17).

What is argued here is that a convergence can be detected towards a global model, characterized by a convergence in the content of research, the process of research, and the institutional system in which research becomes embedded. In terms of the content of research activity, the global model of the Center of Excellence and Relevance tend to focus on certain emerging technologies that are expected to hold a strong potential for future application. These hot spots of science can currently be found in fields like nanoscience, biotechnology, energy research, information technology, materials science, etc.

Some of the rapidly advancing and converging technologies are sometimes referred by their acronym 'NBIC' technologies: nanotechnology, biotechnology and biomedicine, advanced computing and information technologies and cognitive neuroscience. New developments in each of these technologies will have a significant impact on the economy, society and maybe even humanity and the most fundamental innovations will likely occur at their intersections. Most countries and universities include all of most of these fields in their national or institutional research priorities and accordingly, this are also the fields where much of the research funding is concentrated. A second characteristic is related to the process of research and innovation and is characterised by an organisational integration of activities. Not just the fundamental research part is done in these centres, but they also tend to focus on the activities such as product development and the dissemination, commercialisation and marketing of such products. This requires new roles for the research centers but often also for the academics that work in them. While in the traditional model researchers were only focused on the pursuit of knowledge, in these new centres they are also expected to perform as entrepreneur. The institutional consequences (and drivers) of the shift in knowledge production are illustrated by models such as the triple helix of university-industry-government relations (Etzkowitz and Leydesdorff, 1997) and national innovation systems (Lundvall, 1992; Nelson, 1993). The premises here is that the dynamic evolution of relationships among the university, industry, and government can help to generate economic growth and social transformation. To encourage these relationships, knowledge needs to be transferred back and forth, from and to these institutions. In terms of cooperation, this has led to an increased call upon universities to establish linkages with industry and with governments. These linkages form channels through which knowledge can be transferred and feedback can be provided. These linkages can be institutionalised in the form of contractual agreements (R&D joint ventures and the like), licensing agreements, or more loosely structured arrangements like the establishment of science parks near universities. In other cases, universities can transfer their knowledge to the market by engaging in commercial ventures themselves, like is the case in the creation of university spin-offs and the commercialisation of knowledge products.

It is argued in this paper that there is a worldwide convergence towards this global model of the CER. This obviously is not an isolated development but is related to further processes of globalisation and the emerging global model (see Deem et al., 2008, Beerkens, forthcoming). They are moving toward a specific spectrum of technologies (such as the NBIC technologies); they are organisationally integrating research, development and commercialisation; and they are increasingly connected with governmental and industrial partners. At the same time however, it is argued that this local model is not just transplanted from one context to another, but that – in the process of adoption – this model is adapted to local circumstances. These circumstances can relate to the physical aspects or location of the country, to the economic situation, to the historical path through which higher education and research have developed, to the cultural specificities, to the policy context, etc. These local circumstances are likely to impact upon the processes of adoption and adaptation, leading to situations where global models become locally re-invented and re-contextualised. This is likely to result in a situation where the policies which are shaped by certain global models and prescriptions show a gap with actual practices. Global models become decoupled or loosely coupled from the local context. Drori et al. (2003) for instance observe a greater extent of loose coupling in situations where financial resources are scarce (like in developing countries) or where there is uncertainty about the path to follow. In the remainder of this paper, we will explore the way in which re-invention or re-contextualisation takes place and the extent to which this leads to a loose coupling – or maybe even decoupling – between global prescription and local practice.

Centres of Excellence and Relevance: Three Examples

Biotechnology Research Centre (ITB, Indonesia)

The Biotechnology Research Centre is located on the campus of Institut Teknologi Bandung, Indonesia. The Bandung Institute of Technology (ITB) is the country's flagship technological university. Indonesia's higher education system exists of more than 2800 institutions of which only 82 are public institutions. In 1999, the Indonesian government selected its best universities and gave them the autonomy status. These four institutions, Universitas Indonesia in Jakarta, Universitas Gadjah Mada in Yogyakarta, Institute of Agriculture in Bogor and ITB were given the role of pioneers in this reform and were later followed by several other universities. ITB was one of the pioneers and saw its autonomy increasing, but with it came also the pressure to find additional funding on the market. What resulted was an increase in tuition fees and a growth of entrepreneurial activities on campus, in teaching as well as research.

Research on biotechnology at ITB emerged in the early 1980s. The Biotechnology Research Centre was one of three centres in biotechnology that were funded by a 150 million (US$) World Bank loan. The centre in ITB was to become a centre of excellence in the field of industrial biotechnology, while the two other centres, one at the Agricultural Institute in Bogor and one at Gadjah Mada University in Yogyakarta, would specialise in agricultural and medical biotechnology respectively. In this stage, biotechnology also became a national priority for the Ministry of Research and Technology and also formed an element of the fifth five-year development plan of the new order government. In 1994 the field of biotechnology became more institutionalised through the establishment of the Indonesian Biotechnology Consortium. This consortium consists of the three centres, governmental research institutions and private parties and was aimed at strengthening the activities in biotechnological R&D and facilitate cooperation. Public Private cooperation took place mainly with the pharmaceutical and food industry (Witarto 2006). Government funding for biotechnological research in the 1990s came through the general research funding programmes of the Ministry of Research and Technology, such as the RUT, a programme funding multidisciplinary and excellent research on a competitive basis. Much of the funds here also went to the agro-biotechnology and the medical biotechnology. Out of necessity, the centre in its current form is flexible in terms of its size. All faculty members are employed in the faculties, not in the centres. The amount of people is therefore very much related to the projects that the centre has got. For 2007 it was planned to have 30 or 40 people involved[1]. The number and size of the projects in turn is very much related to the involvement of private funders. The funding that the centre receives annually varies, but the proportion from the private sector is higher than government funding or institutional resources[2].

In the past ten years, the research in biofuels has become one of the main areas of research in the Centre. The extraction of oil from palm trees or jatropha plants was the area of specialisation of the current Head of the Centre, Robert Manurung. Manurung developed his expertise on biofuels during is Ph.D. research at the University of Groningen in the Netherlands and his postdoctoral research at the Massachusetts Institute of Technology in the first half of the 1990s. After his return to ITB he became involved in the Centres research on the use of the jatropha plant as a source of biofuel. After the Asian economic crisis hit Indonesia in 1997 and 1998, the funding from government sources plummeted. The research on biofuels was denied a RUT grant because the research was not of direct importance for the development of the nation and the recovery of the economy. With Indonesia's increasing dependence on foreign fossil fuels and the global awareness of its environmental impacts, the national and international attention for research on biofuels increased. In this century, Malaysia and Indonesia became the two largest exporters of palm oil, the most important source of biofuel and crude palm oil is now one of Indonesias major export products. However, the risk of deforestation and worries about palm oil plantations occupying fertile ground for food crops, led to an ongoing interest for alternative biofuels. The jatropha plant as an alternative source of biofuel, takes some of those risks away since it is not edible and it can grow on the arid lands of eastern Indonesia (as opposed to the tropical rainforests in Sumatra and Kalimantan. The renewed interest in jatropha oil enabled the centre to counter the decline of government funding by searching funding from private and international sources. Manurung continued his cooperation with the University of Groningen, which agreed to fund part of his research. In 2004, the New Energy and Industrial Technology Development Organisation, from Japan funded joint research with the Mitshibishi Research Centre and various private partners (i.e. Biochem Prima Internasional, Rajawali Nusantara Indonesia) funded further research on the use of pure jatropha oil. In 2005, the Dutch Academy of Sciences funded a joint project to continue the research on jatropha oil. In addition to the Biotechnology Research Centre, two Dutch universities (Groningen and Wageningen) and the BPPT, a national research centre, are

[1] Interview Robert Manurung, 4 September 2006.

[2] Supra note 1.

involved. This project, running from 2006 until 2011, also includes the training of Indonesian PhD students and postdocs, through a sandwich formula where students conduct research in both countries. The cooperation with the Dutch universities has also triggered the interest of Dutch companies willing to import pure jatropha oil. In the summer of 2006, Manurung teamed up with the Indonesian division of National Geographic to test the potency and efficiency of biodiesel from the jatropha plant. To promote the use of the biofuel, a 3000 kilometre expedition was organised from Atambua in Indonesia's east to the capital Jakarta using jatropha oil as fuel. Earlier that year, President Yudhoyono had issued a decree on the promotion of biofuel. This presidential decree was followed up by negotiations with local and foreign business to further develop biofuel in Indonesia leading to agreements worth a total of 12,4 billion US Dollars. Although the bulk of Indonesia's biofuel production in the short term is expected to come from palm oil-based biodiesel, through further research the centre hopes to develop more efficient processes for the extraction of oil from the jatropha plant.

Institute for Research in Molecular Medicine (Informm, USM, Malaysia)

The Institute for Research in Molecular Medicine is part of the Universiti Sains Malaysia (USM), Malaysia's second university established in 1969. USM is one of Malaysia's 17 public universities. In addition there is a vast private system, consisting of more than 600 institutions. In the 1990s, Malaysia embarked upon a reform process which should make the system more responsive to national needs. As part of this reform, universities – including USM – became corporatized after 1998. Corporatized universities were meant to gain considerable autonomy, enabling them to enter into business ventures and start up companies. They are also are expected to attract resources through tuition fees, consultancies for industry and government, short-tern courses, etc. Although autonomy was formally increased, the universities have been kept under tight government control. Even though pockets of entrepreneurialism have emerged and universities have set up a wide range of new ventures, much of the research funding is still provided by the government, staffing is managed by the government and the government keeps a strong grip on the type of programmes on offer. In 2008, USM was the first university to be granted the APEX status (accelerated programme for excellence) as part of the government objective to establish a number of 'world-class institutions' in Malaysia. This status comes with a considerable increase in government funding.

Informm was established in 2003 and is affiliated with the School of Medical Sciences at the USM Kelantan campus. The school, established in 1979, is organised around interdisciplinary clusters, one of them being the Medical Biotechnology Programme, initiated after receiving an IRPA grant in 1988. The IRPA grants (Intensification of Research in Priority Areas), have been the main source of government funding for university research since its introduction in the Fifth Malaysia Plan from 1985-1989. The current emphasis in terms of research areas were already apparent at that time: diagnostics, vaccinology and biomaterials were the three main groups working together in the Programme. In the Medical Biotechnology Programme, the commercialisation of research played an important role from the start and already in 1994, kits to diagnose typhoid were brought to the market. To speed up the transition from the university's laboratories to industry, the university set up the Centre for Medical Innovations and Technology Development (CMITD) in the year 2000. This centre was meant to exploit the universities patents and develop biomedical products, devices and technologies in the fields of rapid diagnosis of diseases that were relevant to the region. In its early years, the centre continued its successes in the development of rapid diagnostic devices for diseases such as typhoid and brugian filariasis. Diagnostic kits for these diseases were commercialised in cooperation with a company called Malaysian Bio Diagnostics Research (MBDr), and were marketed internationally, first in neighbouring countries in Southeast Asia, but later also in South Asia, Africa and Latin America. After an internal audit of the University in 2001, the field of medical biotechnology, and more specific, molecular medicine, was recognised as one of the priority fields for USM. Therefore in 2003, the Institute for Research in Molecular Medicine was established and officially recognised by the Ministry of Higher Education. The official recognition of Informm by the Ministry fits the wider science and technology policies of the government. In the Eight Malaysia Plan (2001-2005), biotechnology was designated one of the five core technological areas on which Malaysia should focus in order to become a developed country in 2020 (the so-called Vision 2020, laid down by former Prime Minister Mahathir). The designation as a core area also led to increased investments. While from 1986 until 2000, Informm was awarded seven million Malaysian Ringgit, in the period of the Eighth Malaysia Plan this increased to 22 million.

Informm was formed in order to integrate all research at USM focussing on molecular medicine, drawing groups together from different schools (health, medicine, dentistry, veterinary sciences). The institute remains involved in areas like vaccinology and biomaterials, but the research on rapid diagnostics has remained the pillar of biomedical research in the institute and is being expanded to diseases such as cholera, dysentery and tuberculosis. The institute integrates research, development and commercialisation into one organisation, an approach which is enthusiastically backed by the Instiute's director Asma Ismail, who since 2001 was also director of CMITD. In order to integrate research, development and commercialisation, the centre increased cooperation with USAINS, the university's holding company (established in 1998). USAINS had the expertise on issues like patenting and intellectual property and had the necessary links to corporate networks of which Informm has benefitted in the subsequent years[3]. In the field of diagnostics, Informm continued its further development and refinement of diagnostic kits. For their commercialisation, ties with MBDr were further strengthened with the help of USAINS. In 2005, USM signed an agreement with the company and Informm was designated a strategic technology partner. This included an agreement to license the technology for five new products for the detection of infectious diseases. In 2005, the centre was responsible for almost half of all patents filed by the Universiti Sains Malaysia (29 out of 64)[4].

Bio-Organic Materials and Devices (Biomade Technology Foundation, RuG, Netherlands)

Biomade is connected to the University of Groningen, the second oldest university in the Netherlands, established in 1614. The Dutch higher education sector has 14 universities, three of which are technological universities, one is agricultural and one is a distance education university. In addition to universities there are over 40 Hogescholen, or Universities of Applied Sciences providing more vocationally and professionally oriented programmes. Scientific research is almost solely the domain of the universities. Since the early 1980s the universities have gradually increased their autonomy. Even though public funding remains important for teaching and basic research, universities have a high degree of freedom in the way they allocate their resources and in the way search for additional funding. In terms of research funding, the resources have become more divers with funding coming from the Minstry of

[3] Interview Isma Ismail, 2 October 2006.

[4] Supra note 3.

Education, Culture and Science, from the Ministry of Economic Affairs, the Dutch Science Foundation (NOW) and the European Union. Increasing emphasis is placed on acquiring funding from private sources and establishing research links with industry. Biomade is an illustration of such a shift and of the blurring of boundaries between university and industry.

Biomade's activities focus on the intersections of biotechnology and nanotechnology and their biomedical applications. Biomade is different than the other two centres in the sense that it is formally not part of the university, although it is closely connected to it through various ties and networks. Biomade is officially a foundation under Dutch law and is run by George Robillard, who is also a professor of biochemistry in the faculty of natural sciences and mathematics in the university. The roots of Biomade can be traced back to the early nineties. At that time, the university was involved in a reorganisation process where they adopted the global trend of breaking down barriers between disciplines in order to promote more interdisciplinary and multidisciplinary research. A group of researchers from disciplines like biology, chemistry and physics wanted to explore whether there were any opportunities in the new field of nanotechnology. The group decided to get together on a regular basis, to informally present and discuss their areas of research. These sessions led to an aspiration for further and more institutionalised cooperation and therefore, the group decided to look for subsidies and research funding[5]. However, nanotechnology had not yet reached the status that it would have ten years later and the applicability of nanotechnology was not yet recognised. Initially therefore, none of the funders were interested. In 1996, the Ministry of Economic affairs initiated a programme to establish so-called 'Technological Top Institutes', which were meant to be research institutes with a high level of interconnectedness with industrial partners. Even though the group was formally not eligible for the funding since there were no industrial partners at that time, they developed and submitted a proposal (also on the insistence of the university's executive board). The proposal was selected by both selection panels (one assessing the scientific value, one assessing the commercial value), but was later rejected on formal grounds by the minister, because Biomade did not comply with the criterion of industrial partnership. However, this experience did 'get the word out' and led to the recognition of the potential of Biomade and research in the field of bio-nanotechnology.

With the help of a local entrepreneur, Biomade later managed to attract seed funding from the local and regional government. This gave them an opportunity to further develop their plans. First, the strategy was to develop knowledge through research and license it to industrial partners. This approach however appeared to be incompatible with the needs of industrial partners. Existing companies were looking for products, and not willing to invest in the development of new technologies and new knowledge. As a response, Biomade changed its strategy and started looking for investors, rather than licensing their knowledge to private partners. In the late 1990s, a consortium of two multinationals, the University of Groningen and the Investment and Development Agency for the Northern Netherlands (NOM, a Public Limited Company with the State of the Netherlands and the three Northern provinces as its shareholders). This seven million euro investment was matched by the Ministry of Economic Affairs through ICES/KIS 2, a programme focused on the improvement of the national knowledge infrastructure. In 1999, the Biomade Technology Foundation was formally established together with Applied Nano Systems BV (ANS), a company aimed at exploiting the technologies developed in Biomade and the formal proprietor of the intellectual property (Biomade itself was not established as a private company because of legal reasons. The government support to a private company might be perceived as an illegitimate

[5] Interview George Robillard, 24 November 2006

government subsidy). In a consecutive ICES/KIS round for the period 2004-2008, Biomade was awarded another seven million Euros to continue its work, again under the condition that the venture would be a public-private partnership. Private funding however was getting increasingly harder to attract. Because of the economic recession, the initial investors withdrew and other investors were not willing to take the risks. Therefore, in 2003, ANS was taken out of the market and all shares were taken over by the University of Groningen, which now is the owner of the patents filed by Biomade. Despite these setbacks, Biomade continued with the development of two spin-offs. In one spin-off, Gelomix, a new technology will be marketed to create gels that enable easier and more efficient drug delivery (and might be applied in the cosmetics industry as well). This company however ceased to exist. Mucosis, the second spin-off, focuses on the development of mucosal vaccines. Biomade has developed a technology which employs lactic acid bacteria as the basis for a vaccine which is to be administered nasally or orally. This technology has been licensed out to Mucosis. In 2007, Mucosis attracted further investments from a consortium led by BioGeneration Ventures (which is itself a public-private partnership, investing in start-ups in the Life Sciences), MedSciences Capital and the NOM. In a 2006 progress report, the scientific activities in Biomade were assessed very positively. However the committee did voice its concerns about the absence of private funding of ongoing activities and was not convinced that enough private capital could be generated through Mucosis or through other means. This concern is still present and will remain an important issue in the decision on whether Biomade will receive further government funding after 2008. The difficulty in attracting investors has also led to Biomade revising its initially ambitious objectives. Although the first plans talked about a centre with one hundred employees (foreseen for 2003), the current vision is to keep the current size, with around 35 to 40 researchers involved in Biomade's research activities.

Centres of Excellence and Relevance: Global Models and Local Variation

Although the examples above clearly show that CERs have developed in different ways in different places, it is possible to identify a common paradigm out of which the centres developed. First, breaking down barriers between disciplines to enable multidisciplinary and interdisciplinary research played a major role in the establishment of each of the three centres. Emerging technologies such as biotechnology and (bio-)nanotechnology required expertise from physics, chemistry and biology, disciplines that were formerly separated through the compartmentalisation of faculties and national and institutional policies recognised this. The focus on the relatively new fields of biotechnology and nanotechnology is not limited to the centres portrayed here, but is also apparent in other centres and institutions. Fields like nanotechnology, biotechnology, information technology and cognitive sciences – all of an interdisciplinary nature – are present in national and institutional research priorities in each of the three countries. The second element of the common paradigm is the understanding that activities related to research, development and commercialisation needed to become integrated organisationally. In 'the new production of knowledge', research, development and commercialisation could no longer be done by different sectors. In order for research results to benefit society and economy, researchers could no longer limit their activities to publications and patents but became actively involved in the development of products based on these technologies and in the commercial exploitation of them. Through this, research no longer is determined by disciplinary requirements, but became more related to national or local needs and circumstances. This relates to the third element in the common paradigm, the increased interaction with the social and economic environment, with government and industry. Universities and their centres become more oriented towards serving the economic and social needs of their communities. The three centres and their leaders have issues like economic development and social responsiveness in mind in determining the research and commercialisation strategies. This not necessarily replaces the disciplinary and scientific criteria, but it complements them. This new openness of the university requires increased interaction with the other participants in the national innovation systems and creates new dependency relations for the centres. Nevertheless, a closer look reveals substantial variation in these common elements. The shift towards the emerging NBIC technologies, integration of research-development-commercialisation activities and the mergence of a complex set of university-industry-government linkages, play out in different ways in different countries. This section will analyse how local and national factors have impacted upon these common elements in order to explain why the centres have develop in very different ways even though they stem from a common global model.

GLOBAL SCIENCE AND LOCAL PRIORITIES

Research on biofuels, diagnostics for infectious diseases and methods for drug delivery shows how science is on the one hand a global activity but is also responsive to local demands and circumstances. Both the Biotechnology Research Centre in Indonesia and Informm in Malaysia have adapted their research to local circumstances. The focus on biotechnology in Indonesia, emerging in the 1980s and becoming institutionalised in the 1990s is directly related to national needs and national opportunities. Increasing agricultural production and utilisation of the nation's biodiversity for medicinal purposes were the main rationales for the biotechnology centres in Bogor and Yogyakarta. The global attention for alternative energy sources and the high fuel subsidies of the Indonesian government made the interest for research on biofuels an obvious one. With the increasing worries about the efficiency and the social and environmental risks of palm oil, research on alternative sources like the jatropha plant has emerged. In addition to the global problem of global warming, the research on Jatropha might also address more local problems that might benefit from the research. For instance, the research on jatropha oil can have positive social and environmental side-effects on unemployment in rural areas in the East of the country and on combating deforestation in Kalimantan and Sumatra.

Informm's research in the area of diagnostics can also be traced back to specific national circumstances. The institute has focused on those diseases that are present in particular in Southeast Asia or tropical countries in general, both for humanitarian reasons as well as for financial and strategic reasons. The diagnostic kits developed by inform make the detection of diseases possible in a matter of hours instead of days or even weeks. But the area of research is also a strategic choice. Research on HIV for instance would be too costly and would place Informm in competition with world class research centres from the United States, United Kingdom and other developed countries. By carving out its own niche in the research on diagnostic devices and specialising in tropical infectious diseases and issues that are especially relevant to Malaysia and Southeast Asia, Informm has created a position where it can excel and where it can distribute and market its technologies globally. The plan is to gradually expand these niches, creating new fields where Informm can compete globally. Expansion is for instance foreseen in fields like gene therapy and tissue engineering. There are a few additional cases which illustrate the influence of local peculiarities on the area of research. The fact that Malaysia is predominantly Muslim for instance has led to research on the use of bovine bones instead of pig bones as a biomaterial. Another example is the development of a test kit that is able to determine the required dosage of medication required by an individual based on its genetic pattern and ethnic group. The appropriate dosage for ethnic Chinese for instance were found to be different than for Indian or Malay people. Clearly, the multicultural nature of Malaysia is a driving force behind this research.

The impact of local factors on the area of research is not really evident for the case of Biomade. The interest in the field of nanotechnology was on the rise in most developed countries at the time when the first ideas for Biomade emerged. The combination with biotechnology and medicinal applications is more related to the existence of those fields in the university, than to direct national or regional needs or conditions. The region in which the centre and the university are located had no existing strengths in these fields. Biotechnology was mainly focused on the agro-industry and nanotechnology related industry was virtually non-existent.

LOCAL INTERPRETATIONS OF THE NEW KNOWLEDGE PRODUCTION AND TRANSFER

The idea that the production of knowledge has changed and that the transfer and application of this knowledge has gained importance over the intrinsic value of knowledge is also apparent in each of the three centres. The original thesis on the new production of knowledge as it was put forward by Gibbons and his colleagues has been radically simplified and collapsed into a single phrase: 'mode 2' (Nowotny et al., 2003: 179). When complex concepts enter the policy arena and start to dominate the discourse, processes of simplification and interpretation will always occur. It is in these processes that global models become adapted to or re-invented for the local context. The idea that new knowledge production takes place in the context of application describes the total environment in which scientific problems arise, methodologies are developed, outcomes are disseminated, and uses are defined (Gibbons, 1994). In this sense it is different from the linear view where basic science, generated in theoretical/experimental environments, is applied. In Malaysia, the emphasis in the new production of knowledge is on the coupling of – formerly – separate activities in the process. This is clearly reflected in the new 9th Malaysia Plan with the establishment of the Science Fund, Techno Fund and Inno Fund. Informm in this respect talks about the R-D-C process: research, development and commercialisation. This process however remained largely linear. In the centre there has been an emphasis on integrating these activities into one single unit, while making use of external expertise and networks in some parts of this process (for instance USAINS and MDC). The strong focus on the applicability of research findings is enthusiastically backed by the centre's director who sees it has her task to come up with concrete and useful applications and to get the staff involved in the development and commercialisation activities. The integration of the research, development and commercialisation activities is also apparent in PPBiotek. Research in the context of application has become a sheer necessity, partly because of the lack of research funding in Indonesia. A pragmatic stance towards research and funding has been essential for Indonesian scientists for long, either to avoid government interference or to deal with the decrease in funding after the reforms. One might argue that the move from pure research activities to the inclusion of development and commercialisation activities has not been experienced as a major shift. This was much more the case at Biomade, especially in its early years in the 1990s. By that time, openness and relevance were not as prominent on the higher education agenda as they have been in the last decade and product development and commercialisation were not really considered part of academic work. By now such resistance is still apparent in many parts of higher education, but far less than twenty years ago. This shift from resistance towards acceptance and sometimes embrace of a more entrepreneurial spirit can also be witnessed in Biomade. However, because of various legal obstacles, the activities are formally still separated into different organisations. Research is conducted in Biomade – and still benefits from its close relations to the faculties of the RuG – while patents were accommodated in Applied Nano Systems and product placement actually takes place in the spin offs Gelomix and Mucosis. This reflects the way the public universities have historically evolved, with an emphasis on basic research and non commercial interests. With the transfer of the patents from ANS to the RuG in 2003, the links between Biomade and the RuG became closer again.

In the Malaysian and Indonesian CER, one might argue that the development and commercialisation activities are increasing in importance at the cost of the basic research activities. Both Indonesia and Malaysia both have rather young university systems and do not have a long history of 'mode 1' research. The thesis on the shift in knowledge production however assumes such a history of mode 1 research. The transfer or transplant of such a thesis to post colonial countries might thus entail the risk of incomplete transfer. The CERs in Indonesia and Malaysia do show such a risk of overemphasizing product development and commercialisation over fundamental research. This is also illustrated for instance by the outlets that academics use for their findings. While for Biomade, traditional outlets like academic journals are still important, Informm also frequently visits technology fairs and expositions. PPBiotek also acknowledges this risk and has linked up with partners abroad, which enables them to partly compensate the lack of basic research funding at home. The observation that Mode 1 research is a prerequisite for witnessing a shift from Mode 1 to Mode 2 is a logical observation. Nevertheless the basic research function as a building block for further research, development and commercialisation is often neglected in the transfer of the global model of the CER.

LOCAL EMBEDDEDNESS OF GLOBAL MODELS

A third issue in the local adoption and adaptation of global models is related to the environment in which such models become embedded. This relates to the complex of governmental organisations, research institutions and private actors that constitute the system in which a CER operates. The model of a CER assumes a system in which universities, industry and government work together to create the right conditions for innovative knowledge production and dissemination. Biomade found out in the start that the support of regional and national governments and industry was a prerequisite for the continuation of the centre. However, at that time it was hard to convince these partners of the strategic importance of nanotechnology. Furthermore, there were no significant regional industries that would support the initiative. The developments in Groningen were however not the only ones in the field of nanotechnology in the Netherlands. At other universities, nanotechnology became an important new field (in particular MESA+ at the University of Twente, another research institute that can be labelled a Centre of Excellence and Relevance). Since the early 2000s, the nanotechnology network in the Netherlands became formalised, first through the NanoImpulse funding in 2003 and later the foundation of Nanoned in 2005. This is a national public-private initiative that combines strengths in nanoscience and technology in a national network with scientifically, economically and socially relevant research and infrastructure projects. Nanoned has secured funding of 235 million Euros until 2009, mainly through initiatives and programmes from the Ministry of Economic Affairs. In addition to this national network, Biomade also has links with several regional partners, while it also participates in global scientific networks and. It is this embeddedness in multiple, overlapping networks that have contributed to Biomade's successes and probably even to its survival. Because of the range of linkages, Biomade has been able to activate different networks for different purposes.

In Indonesia, the national government has attempted to set up a network in the field of biotechnology. Since 1985, the country has placed a high priority on biotechnology development in order to address food production needs in a more sustainable agricultural system. During that year, the State Ministry of Science and Technology established a national committee for biotechnology to prepare and formulate national biotechnology policies and programs. It created the Centres in the universities in Bandung, Bogor and Yogyakarta, together with a range of national research institutes, of which the Agency for Technology Assessment and Application (BPPT) for industrial biotechnology in Jakarta is the most important one for PPBiotek. It is this centre which is also involved in the collaborative arrangement between the University of Groningen in the Netherlands, the Dutch Royal Academy of Sciences and PPBiotek. In addition, PPBiotek is also involved in several private networks that invest in the research. PPBiotek has manoeuvred creatively between governmental, corporate and international scientific networks in order to fund its research. Most of these networks however seem rather ad hoc and short term agreements, making the further research on the Jatropha plant and biofuel insecure. The current focus on alternative energy sources and the increasing doubts on the sustainability of palm oil – and its effects on the global food supply – however show opportunities for this research.

Informm's local and national embeddedness very much reflects the Malaysian state-economy relations. Industry is closely connected to the government and – despite the corporatisation policy of 1997 – so are the universities. Informm is on the one side very much dependent on a single source of funding. The main sources have been the IRPA funds, which is now more or less replaced by the Science Fund, Techno Fund and Inno Fund of the 9th Malaysia Plan. Industry linkages are also rather one-dimensional. Informm's corporate partner is Malaysian Bio Diagnostics Research (MBDr), which again is very closely linked to the government. The government however has shown a string commitment to biotechnology, first with the Bio Valley initiative and later with the – more modest – Bionexus Malaysia. This and the increased funding for biotechnology in the 9th Malaysia Plan clearly shows the commitment from the side of the government. This commitment and the resources that come with it has enabled Informm to evolve into a successful research centre which can expect to receive a steady flow of research funding in the future. The long term question therefore is whether the lack of competition will bring the risk of compliance. At this time, it has not. In fact, competition is present, but it seems to be more a competition for prestige then for resources.

CONCLUSIONS

The study of the three Centres of Excellence and Relevance shows that – even though the model of the CER got adopted in the three universities, they turned out to be very different organisations. The difference can be explained by the different ways in which the models got contextualised locally. Local factors impact upon the content of the research and the opportunities for application. This was especially apparent for the Malaysian and Indonesian cases. In both cases, the specific location and geographic circumstances explain the focus on tropical diseases on the one hand and the use of jatropha plants for biofuel on the other. This local contextualisation was not apparent for the Dutch case of Biomade. Local factors also impact upon the organisation of the CERs and the way in which the various activities are integrated organisationally. In the cases of Informm and PPBiotek, the inclusion of development and commercialisation seemed to meet less obstacles than in Biomade. This can also explain the fact that the development and commercialisation phase are less organisationally integrated in Biomade than in the other two centres. The reasons for this might be diverse, but it could be related to the longer history of 'Mode 1' research in the Dutch case. This same issue – the lack of a history of 'Mode 1 research' before embarking on 'Mode 2 research' does leave questions with regard to the transferability of the model. Finally, local factors also impact upon the way such CERs are embedded in and interact with their wider environment. While in Indonesia, the lack of governmental funding resources has pushed PPBiotek towards more private partner involvement and international scientific cooperation, The Dutch and Malaysian cases were embedded in a more supportive environment. In the Indonesian case, one might conclude that the emphasis has been on applied research, not so much on strategic research. However, by tapping into international networks, the centre does form part of a larger complex of biotech research which is more or less strategic in nature. In Malaysia, the environment was characterised by a very statist model. The CER and its partners in this case were more or less an element in the greater Malaysia Inc. strategy. It's therefore debatable whether Malaysia has moved to a real triple helix model. In many ways the process of knowledge diffusion still seems to be a linear one as opposed to the interactive model of government-university-industry relations. The new policies proposed by the 9th Malaysia Plan intend to improve this interaction. The Dutch case was more based on multiple nanotech initiatives in which universities, local and national governments and industry interact on the basis of simultaneously operating collaborative and competitive relationships. However, as is the case with most European countries, there is much evidence of the so-called 'knowledge paradox': while scientific performance is of high quality (in terms of for instance citation-indices), the utilisation of this knowledge in economic processes is lagging behind.

The fact that all three CERs became more or less locally contextualised does not necessarily mean that policy and practice became decoupled. In many cases the local adaptation just mean that the model showed a better fit with the local situation. The study however does show that there is a risk that in the transfer of such models, certain fundamentals cannot be transferred. In this sense it is plausible to expect that the closer the national context is to the one of the origin of the model, the more tightly they will be coupled with practice. The problem is however that such models cannot always be connected to a specific locality. Global models have been decontextualised themselves to some extent. However, it is clear that models like the CER are more closely associated with a western or maybe Anglo Saxon context than with, let's say a Latin American or African context. The CER in particular appears to be closely linked to a context in which basic research is well developed and where university, government and industry all fulfil their own specific role in the research and innovation process. In conclusion we can say that the model of the CER is a useful analytical tool but that in the end it remains a model, simplifying a much more complex reality.

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REFERENCES

Beerkens, E. (forthcoming) Global models for the national research university: adoption & adaptation in Indonesia and Malaysia.

Buchbinder, H. 1993 The market oriented university and the changing role of knowledge. *Higher Education* 26, no. 3: 331-347.

Clark, B.R. 1996. Substantive growth and innovative organisation: new categories for higher education research. *Higher Education* 32, no.4: 417-430.

Clark, B.R. 1998. *Creating Entrepreneurial Universities: Organizational pathways of Transformation*. Oxford: Pergamon Press.

Cummings, W.K. 1998. The service university in comparative perspective. *Higher Education* 35, no.1: 1-8.

Deem, R. K. H. Mok and L. Lucas. 2008. Transforming Higher Education in Whose Image? Exploring the Concept of the 'World-Class' University in Europe and Asia. *Higher Education Policy* 21 No.1: 83-97.

Drori, G.S., J. Meyer, F. Ramirez and E. Schofer. 2003. *Science in the modern world polity,: globalization and institutionalization*. Stanford, CA: Stanford University Press.

Etzkowitz, H. and L. Leydesdorff (Eds.) 1997. *Universities and the Global Knowledge Economy: A Triple Helix of University-Industry-Government Relations*. London: Cassell.

Gibbons, M., C. Limoges, H. Nowotny, S. Schwartzman, P. Scott and M. Trow. 1994. *The New Production of Knowledge: The Dynamics of Science and Research in Contemporary Societies*. London: Sage.

Jongbloed, B. and L. Goedegebuure. 2001 From the Entrepreneurial University to the Stakeholder University. Paper presented at the International Congress on Universities and Regional Development in the Knowledge Society, 12–14 November at Universitat Politecnica de Catalunya, Barcelona.

Lundvall, B.A. 1992. *National Systems of Innovation. Towards a Theory of Innovation and Interactive Learning*. London: Pinter.

Marginson, S. and M. Considine. 2000. *The Enterprise University. Power, Governance and Reinvention in Australia*. Cambridge: Cambridge University Press.

Nelson, R.R. (Ed.) 1993. *National Systems of Innovation*. Oxford: Oxford University Press.

Nowotny, H., P. Scott and M. Gibbons. 2001. *Rethinking Science: Knowledge in an Age of Uncertainty*. Cambridge: Polity.

Nowotny, H., P. Scott and M. Gibbons. 2003. Introduction: `Mode 2' Revisited: The New Production of Knowledge. *Minerva* 43, No. 3: 179-194.

Rip, A. 2002. Regional Innovation Systems and the Advent of Strategic Science. *Journal of Technology Transfer*. 27, No. 1: 123-131.

Rip, A. 2004. Strategic research, post-modern universities and research training. *Higher Education Policy* 17, no. 2, 153–166.

Roco MC, Bainbridge WS (Eds): Converging Technologies for Improving Human Performance. NSF-DOC Report, 2002; Boston: Kluwer.

Tierney, W.G. (Ed.) 1998. *The Responsive University: Restructuring for High Performance*. Baltimore: JHU Press.

Tjeldvoll, A. 1997. *A service University in Scandinavia*. Oslo: University of Oslo/Institute for Educational Research.

Tjeldvoll, A. 1998. The idea of the service university. *International Higher Education* 13, Fall: 9-10.

Witarto, A.B. 2006. Bioteknologi di Indonesia. Kondisi dan Peluang. *Inovasi* 7, XVIII: 39-45.