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A model and system for an integrated analysis of the iterative life cycle of university-industry partnerships

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Abstract

The Asian countries (Sri Lanka, Thailand, Bangladesh) in the ASCENT project have an unequally spread out and restricted RTD ability. An interactive and cooperative university - industry partnership can increase the quality of life and reduce the risk of disaster. Here the fields where universities consider the involvement of industry are recognized (e.g., fundamental and applied research, development, production life cycle and such). There is a recognized need for the private sector to engage the research community in the context of disaster resilience research to tackle disaster risk. The definition of "industry" in this research is deliberately vague to allow exploration of what useful collaborations "industries" can develop with universities for disaster management research (here collaborations mean different life cycle interactions). There is the need for an integrated multiple criteria decision analysis to mitigate the effects of disaster on the built environment at three levels: the micro (research and innovation performance, transfer and absorptive capacity, technology development), meso (institutional arrangements, communication network, local and indigenous rules) and macro (supply and demand, regulations, financing, taxes, culture, traditions, market, climate, political, demographic, technology) levels. Disaster management involves numerous aspects for consideration in addition to making economic, political and legal/regulatory decisions. These must include social, cultural, ethical, psychological, educational, environmental, provisional, technological, technical, organizational and managerial aspects. This research produced a model and a system for integrated analysis of the iterative life cycle of university-industry partnerships. The model and the system make it possible to perform multi-variant design and multiple criteria assessment of alternative university-industry partnership life cycles, calculate their market and investment value,

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conduct online negotiations, and select options that offer the best efficiency.

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Keywords: University-industry partnerships; Multiple criteria modeling; Micro, meso and macro environments; Societal resilience to disasters; Alternatives

1. Introduction

Many scientists and practitioners analysed university-industry partnership models [1-11]. [3] suggest that university-industry linkages (UILs) in Mozambique weak and informal, and that academics engage with companies mainly through UIL-innovation model and exchange of embodied knowledge, particularly ideas in informal meetings, internship/employment for students, consultancies for academics, rather than through disembodied knowledge, such as patents and technology prototypes, embedded in R&D and STI-innovation model. In [4] opinion, the industrial partners do not necessarily have all the competencies to perform each operation in-house for the development of competitive products. [7] present a review of various models that focus on collaboration management, the formation of knowledge integration community, and research collaboration activities between university and industry. [2] adopt the Actor-Partner Interdependence Model (APIM) for the analysis of data on 98 matched pairs of recent UI research collaborations and find that relationship maturity moderates the associations of reciprocal communication and decision process similarity with trust. Drawing on the contemporary turn to discursive practices [6] examine how the organizing practices of industry, university and government facilitate (or impede) developing countries transition to a hybrid triple helix model of innovation. Placing emphasis on the everyday situated practices of institutional agents, their interactions, and collaborative relationships, [6] identified three domains of practices (advanced research capabilities and external partnerships, the quantification of scientific knowledge and outputs, and collective entrepreneurship) that constitutively facilitate (or impede) partnership and in turn the successful transition to a hybrid triple helix model. The open innovation model suggests that firms should combine external and internal ideas and technologies as effective pathways to market when advancing and commercializing technologies [12]. Technology Transfer Offices (TTOs) are the main institutions responsible for the establishment of university–industry partnerships. R&D contracts exemplify the indirect mechanisms through which enterprises and universities collaborate on a win–win basis [5]. [5] study addresses organizational and institutional aspects that act as drivers for the establishment of successful university–industry partnerships (regression models, etc.).

The models mentioned above, along with other models [13-21], looked at the life cycle of university-industry partnerships (UIPLF) and their components from various perspectives. [13] analysed the evolution of university industry linkage phases (pre-linkage that leads to an agreement to work together, establishment that leads to a contract, engagement that leads to the delivery of a project, advancement that leads to an ongoing partnership and word of mouth, and the latent phase that means potential future cooperation should a suitable project arise, with continuing personal linkage). [21] employed a systematic procedure to review the literature on university–industry collaboration. [21] examined three main phases in university–industry collaboration: formation (identifying partners, making contact, assessing partners, negotiation, agreement signing), organizational forms (informal and formal personal relationships, third party, targeted and not targeted formal agreements, focused structures), and operational phase activities (meetings, communication, trainings, personal mobility, employment, other activities).

Major stakeholders are involved in the development of all main life cycle stages. This helps support close links between various stakeholders and university-industry partnership iterative life cycle formation stages.

In an attempt to make the life cycle of university-industry partnerships and their components more efficient, many different databases have been built and information systems created [22-24].

The academic-industry interface system and the interactive academic-industry partnership database enable academic investigators and industry to match up their needs based on complementary knowledge, initiate contact, and work to develop effective partnerships [22]. [23] draws on a database of collaborative research grants between universities and business firms awarded by the UK Engineering and Physical Sciences Research Council (EPSRC). The scope for [23] research collaboration between university and industry varies greatly at the territorial level and in some contexts is potentially high, provided that public and private resources are devoted at identifying and supporting the most effective partnership for the observed region. [24] qualitative research study utilized the grounded theory tradition to examine organizational structures and processes in a purposefully selected sample of top research American universities that have established and maintained partnerships with industry. A set of conditional propositions were developed by [24] regarding the organizational structures and processes (development of a Central database and system containing all corporate activities, by company, across the university, etc.) supporting the establishment and maintenance of partnerships with industry.

Scientists and practitioners looked from various perspectives at possibilities to create a rational micro, meso and macro environment for university-industry partnerships. The level of the rationality of university-industry partnership depends on a number of variables, at three levels: micro, meso and macro level.

The rationality of the university-industry partnership depends on the influence of many integrated macro level factors (supply and demand, regulations, financing, taxes, culture, traditions, market, climate, political, demographic, technology). The rationality level will, therefore, vary depending on the aggregate effect of these macro level factors. Talking about the macro level factors the existing literature releases the Strategic Plan, application development, neighbourhood planning model, disaster management framework and programs (such as Public-private partnerships (PPP)), the strategic collaborations programs, R&D projects, risk reduction policy, policy to change human behavior, a learning culture. According to African Regional Center for Technology, the primary role of The Strategic Plan of African Regional Center for Technology (ARCT) has been taken up with following objectives: to identify the areas where academic institutions include industry participation; to assess the perceived benefit accrued from this partnership in specific areas and incidences. The relationship between Academia and Industry for the benefits of ARCT Member States [25].

The rationality level of university-industry partnership also depends on various micro (research and innovation performance, transfer and absorptive capacity, technology development) and meso (institutional arrangements, communication network, local and indigenous rules, communication network, local and indigenous rules) level factors some of which depend on the influence of the macro level factors. Taking a qualitative approach and using university-industry collaborative projects set in Finland and Russia [26] identified a common set of micro level key performance indicators (KPIs) across the university-industry collaboration (UIC) lifecycle at a micro level. Namely, the amount of resources allocated by partners to collaboration; efficiency of collaboration management and clearly defined roles; as well as a number of company innovations resulting from collaboration with a university and new strategic partnerships. [26] study also found contextual micro level KPIs as number of young researchers involved, fit between collaboration and organizational strategy; number of joint publications; enterprise image improvements. [26] define those metrics, which among other existing KPIs depend on the case context (region, research area, industrial sector and partners' goals). According to [27], the long-term project has enhanced learning outcomes of enterprise computing technology students at NCA&T, area community colleges, and high schools by engaging students in applied research and providing hands-on experienced-based learning. This college-industry partnership model can be replicated readily at other institutions in need of an equipment infrastructure to foster education and research. Disaster-Resistant Information Communication Network established by Tohoku University, which is based on industry-academia-government collaboration to achieve the most advanced disaster-resistant information communication network in the world [28]. An insurance premium reduction program by Suncorp known as the 'Cyclone Resilience Benefit' reviewed by [29] is one more university-industry partnership meso level factor. The program delivery to over 14 000 homeowners to date. The development of this industry program based on academic research demonstrates the benefits of strategic partnerships in the field of natural disaster risk mitigation. According to [30] the public and private partnerships factor is a new approach, to acknowledge the multi levelled nature of resilience; risk at the relevant levels are taken into account, (regional/river basin, urban area, and individual).

It may be noticed that the researchers engaged in the analysis of university-industry partnership life cycle and its stages did not consider the research subject being analyzed by the authors of the present investigation. The latter may be described as follows: a life cycle of a university-industry partnership, the stakeholders involved in its cycle as well as micro, meso and macro environment having a particular impact on it making an integral whole.

2. A model for an integrated analysis of a university-industry partnership iterative life cycle

In order to design and realize a high-quality partnership, it is necessary to take of its rationality from the awareness to the strategic partner. The entire process must be planned and executed with consideration of goals aspired by participating stakeholders and micro, meso and macro context. In order to realize the above objectives an original Model of an integrated analysis of a university-industry partnership iterative life cycle (see Fig. 1) was developed enabling to analyze a university-industry partnership iterative life cycle, the stakeholders involved in the partnership as well as its micro, meso and macro context as one complete entity.

A model for an integrated analysis of a university-industry partnership iterative life cycle was being developed step by step as follows:

Stage I. A best practice description is written on a university-industry partnership in different countries [1-16, 21-31] which includes: 1) A system of criteria that characterizes university-industry partnership efficiency as established by relevant literature and expert methods. 2) A description based on this system of criteria in conceptual (textual, graphical, numerical, etc.) and quantitative forms on the present state of university-industry partnership in different countries.

Stage II. A comparison and contrast of university-industry partnership in different countries are performed [1-16, 21-31] which include: 1) An identification of global development trends (general regularities) in university-industry partnership. 2) An identification of university-industry partnership differences between developed countries. 3) A determination of the pluses and minuses of these differences. 4) Establishment of the best university-industry partnership practice for the ASCENT project based on actual conditions. 5) An estimation of the deviation between the knowledge that stakeholders have about the best practices worldwide and their practices-in-use.

Stage III. Some general recommendations are developed on how to improve efficiency levels for stakeholders.

Stage IV Certain recommendations are submitted for stakeholders. Each general recommendation proposed in Stage III contains several specific alternatives.

Stage V A multiple criteria analysis is performed on the components of university-industry partnership, and the most efficient version of the life cycle of university-industry partnership is selected. Next obtained compatible and rational components of one type of university-industry partnership are joined into a full, university-industry partnership process.

Stage VI Transformational learning is performed, and the mentality and actual behavior in practice are redesigned.

The above model will be now described in more detail. For more integrated study of a subject under analysis and methods and ways of its assessment major components of the above subject will be briefly analyzed. They are as follows: a university-industry partnership iterative life cycle, the stakeholders involved in the partnership development and micro, meso and macro context having a particular impact on it. A university-industry partnership iterative life cycle in turn consists of five closely interrelated stages, such as awareness, involvement, support, sponsorship and strategic partner.

[14, 15] investigated the university-industry partnership continuum spanning five stages: awareness (career fairs, interviews), involvement (industry affiliates, advisory programmes, research grants, internships, software grants), support (student consultants, hardware grants, curriculum development, workshops and seminars, student organization sponsorships, philanthropic support, guest speaking/lectures), sponsorship (university initiative sponsorships, undergraduate research programme support, graduate fellowships, collaborative research programmes, outreach programmes, support for proposals for education), and strategic partner (executive sponsorships, joint partnerships, state education lobbying, major gifts, business development). The university-industry partnership continuum [14, 15] proposed was later adapted by several other scientists and practitioners [16-20]. We have also applied this university-industry partnership continuum in our research. A conceptual model (see Figure 1) was created and possibilities to use it in real settings (see Figure 2) were outlined based on an analysis of the aforementioned university-industry partnership (UIP) models, the UIP life cycle and its components, possibilities to create a rational UIP micro, meso and macro environment, and available UIP databases and their information systems.

A university-industry partnership iterative life cycle may have a lot of alternatives. These variants are based on the alternative awareness, involvement, support, sponsorship, strategic partner components. The above solutions and processes may be further considered in more detail. Thus, dozens of thousands of university-industry partnership iterative life cycle alternatives can be obtained. Development of potential university-industry partnership iterative life cycle is complicated by the fact that the considered alternatives of awareness, involvement, support, sponsorship and strategic partner are plenty and not always compatible. It should also be kept in mind that the improvement of some aspects of certain stage operations may lead to the deterioration of the indices of other stage or processes. Since the rationality of various aspects of partnership often depends on a particular stakeholder only integrated design of a life cycle process of a university-industry partnership involving close collaboration of major stakeholders can lead to good results. Various stakeholders are involved in the awareness, involvement, support, sponsorship and strategic partner of a university-industry partnership, their cooperation taking rather long period of time.

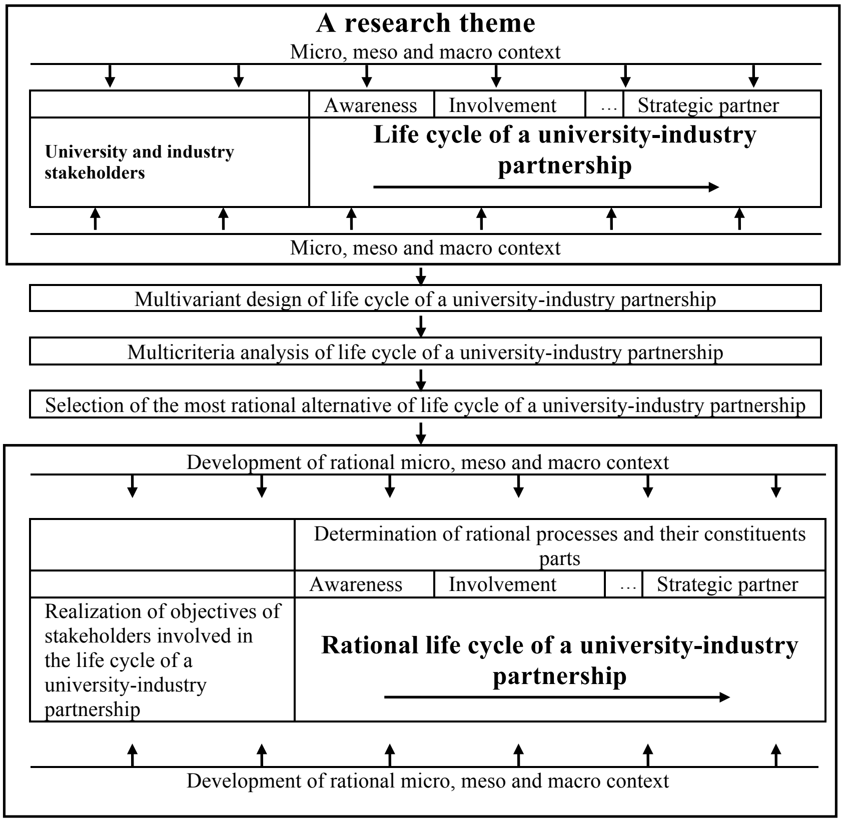

Fig. 1. A model and system for an integrated analysis of the iterative life cycle of university-industry partnerships

University (students, governing board, rector, vice-rectors, deans, chairs, teaching and research staff, administrative and support staff) and industry (top management (chairman, vice-presidents, board of directors, chief executive officers), middle management (general managers, regional managers), first line management (supervisors, office managers, team leaders), employees) stakeholders develop and analyze the alternative partnership solutions.

The study aims to develop a model and system for an integrated analysis of the iterative life cycle of university-industry partnerships and to outline the possibilities to apply the model in real settings. An analysis of similar previous research [1-15] suggests that the models and systems available around the globe have offered no possibilities to perform multi-variant design and multiple criteria assessment of alternative iterative life cycles of university-industry partnerships, calculate their market and investment value, conduct online negotiations and select options that offer the best efficiency.

The SurveyMonkey questionnaire includes 41 questions. The first seven questions collect background details about respondents. The questionnaire comprises five main parts: Awareness, Involvement, Support, Sponsorship, and Strategic partnership by the type of partnership. The Dichotomous Questions make the largest portion of our questionnaire in the main part of the survey. This type of questions within questionnaires gives two options to the respondent – yes or no. This online questionnaire is available at https://www.surveymonkey.com/r/NM7KNVY.

Our online survey ran into three typical problems: respondents found the questions unclear or confusing, respondents believed the questions did not categorize precise issues or problems, and the online survey failed to provide our respondents with the ability to explain their responses. The telephone survey resolved these issues. Some of our target groups had no access to the internet. Therefore, we used hybrid SurveyMonkey and telephone surveys to reach respondents most familiar with the main point of our research; all stakeholders were also offered a possibility to take part in the survey online. In total, 37 respondents were surveyed by phone.

Several Asian countries (Sri Lanka, Thailand, Bangladesh) and Lithuania are participating in the ASCENT project, which was the reason they were our choice for the survey. The differences in understanding, geographical location and different disasters in the surveyed countries allow us to compare the similarities, differences and peculiarities characteristic of university-industry partnerships in the field of disaster management.

The questionnaire continues to be open for the collection of results. The data collection started on 1 May 2017. As of 12 July 2017, there were 44 answers from the following countries: Lithuania (79.55%), UK (11.36%), Thailand (6.82%), others (unidentified; 2.27%). The majority of the respondents were younger than 44 (61.37%); universities (45.45%), businesses (38.64%) and students (15.91%) took part in the survey. Respondents were asked to evaluate the severity of disasters in their countries. The rating was as follows: 72.09% were rated as emergencies, 18.60% as disasters, and 9.30% as catastrophes. The answers to the survey question "Do industry ambassadors participate in university education process and project activities?" were as follows: 54.55% of the respondents answered yes and 45.45% answered no. To the question "Are industry ambassadors recruiting/offering placements to students in their companies in disaster management industries?" 38.64% of the respondents answered yes and 61.36% answered no. To the question "Do industry companies share their experience on disaster management issues with university staff?" 31.82% of the answers were yes and 68.18% were no. A full overview of the survey will be presented in our future full-scale article.

Based on this university-industry partnership iterative life cycle integrated analysis model, professionals involved in design and realization of a university-industry partnership iterative life cycle can develop a lot of the alternatives as well as assessing them and making the final choice of the most efficient variant. This also leads to better satisfaction of the needs of all stakeholders involved in the partnership design and realization.

3. Practical realization of a Model for an integrated analysis of a university-industry partnership iterative life cycle

A practical realization of a model for an integrated analysis of a university-industry partnership iterative life cycle was being developed step by step as follows: 1) An integrated numerical and qualitative description of the life cycle of a university-industry partnership, its stages, stakeholders and context; 2) Development of an integrated database based on questionnaire results, numerical and qualitative description of the subject under analysis; 3) Adaptation of multi-criteria analysis methods (COPRAS [17], INVAR [18-20, 32], etc.) to perform multivariant design of a university-industry partnership iterative life cycle, determine the utility degree, market and investment values of the alternatives obtained and set the priorities; 4) Creation of a multiple multiple criteria decision support systems to be used in computer-aided multivariant design of a university-industry partnership iterative life cycle, determining the utility degree of the obtained and setting the priorities; 5) Analysis of micro, meso and macro context factors influencing a university-industry partnership iterative life cycle and possibilities to alter them in a desired direction.

Particular stakeholders often have their own preferential rating of these indicators, also giving different values to qualitative characteristics. Besides, designing of a university-industry partnership iterative life cycle allows for the development of plenty of the alternatives of its particular stages. The application of integrated database described allows to better satisfy the needs of the stakeholders involved as well as helping to choose a rational partnership form. These integrated database can contain data on theoretical and practical experience of the stakeholders, some additional facts as well as the recommendations as to how to avoid previous mistakes.

An integrated database consists of the following parts: 1) Initial databases. These contain the initial data provided by various stakeholders allowing perform an integrated design of the whole partnership (awareness, involvement, support, sponsorship and strategic partner) or its parts; 2) Evaluation databases, containing integrated numerical and qualitative information provided by stakeholders allowing get a full description of the partnership (awareness, involvement, support, sponsorship and strategic partner). Based on the evaluation databases multi-criteria investigation of a university-industry partnership iterative life cycle and its stages is performed; 3) Multivariant design databases consisting of integrated numerical and qualitative information about potential permutations of the variants available.

The use of integrated database enables the stakeholders to take into account university and industry knowledge in various fields and the previous experience gained in developing similar partnerships applying them to currently developed partnership. For getting more rational partnership forms this information should be used at an early stage when the first meeting, which could save from repeating prior mistakes as well as leading to a more advanced and rational partnership form.

A System for an integrated an analysis of a university-industry partnership iterative life cycle consisting of a databases, database management system, a model base, model base management system and the stakeholder's interface was developed to be used for a university-industry partnership iterative life cycle design and multi-criteria investigation. For example, the system using these databases can help compare the partnership being designed or executed with the alternative or already realized partnerships in order to find its disadvantages and provide recommendations as to how to increase its rationality.

4. Conclusions

None of the aforementioned university-industry partnership (UIP) models, investigations of the life cycle of UIP and its components, feasibility studies looking to create a rational micro, meso and macro environment for UIPs, or available UIP databases and information systems offered things this research does. This research produced a model and a system for integrated analysis of the iterative life cycle of university-industry partnerships. The model and the system make it possible to perform multi-variant design and multiple criteria assessment of alternative UIP life cycles, calculate their market and investment value, conduct online negotiations, and select options that offer the best efficiency. So far this has never been done in the world.

We now will overview the results of our hybrid SurveyMonkey and telephone surveys. The questionnaire results show that university–industry partnerships exhibit a medium degree of interactivity, which might generate stimulating learning opportunities and offer know-how of disaster issues and market trends indispensable in an integrated training of academics. The questionnaire results suggest that universities and governments must create policies and incentive structures that encourage academics to reach a relevant balance between basic and applied research activities. Governments should ensure successful university–industry collaboration, as well as identify the capacity of each university to collaborate with a specific industry. Universities must also contribute towards strengthening their relationship with industry. The questionnaire results show that universities are willing to support industry, but lack of industry investment means they get no funding for their efforts. Also, it is important that governments support and publicize collaborative sustainability R&D efforts where the results are meaningful for many and for the future. Huge achievements are possible at the micro level, given stakeholders, willing researchers and direct government support are available. We, thus, think that governments should include support for typical emergency activities in their policy frameworks. The questionnaire results show that if universities and businesses are willing to work together and foster better understanding in the future, more valuable as well as sustainable partnerships can be created. The importance of university and industry partnerships has been long a known fact.

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