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Roadmapping the Operationalization of License-Master-Doctorate System at the University of Antananarivo: a case study

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ABSTRACT
The purpose of this paper is to present a framework for planning and implementing the new University Educational System, License-Master-Doctorate, aligned with the National Plan of Development 2015-2019. Benchmarking or Competitive Intelligence is used to identify the best Master program. The proposed framework, to plan and implement that program, is the Technology Roadmapping approach. The results show a global Master program profitable economically for the above National Plan of Development. For the latter, an integrated Roadmap takes in account and in time different items to tackle the strategic orientations.

Keywords: *Benchmarking, Economic Evaluation, Master Program, Technology Roadmapping*

1. INTRODUCTION

According to Vaitilingam [19], research is our future and key driver of economic growth. Experience in English speaking countries points out that changing university education system into "License-Master-Doctorate or LMD" will play a determinant role in such research. Some Departments of the University of Antananarivo have converted its "Diplôme d'Etudes Approfondies or DEA" into "Master of Science or MSc". It is the case of the "DEA Ingénierie de Projet Industriel". That conversion process is multifarious and challenging. Besides, its implementation has taken a long time because of interesting and important discussion and debate. So far, many stakeholders, above all an important percentage of teacher researchers, are not yet adhering to the process. They do not have sufficient information to appreciate the change and its objective. The method to undertake such change seems to be top-down and does not take in account the university realities.

The research questions are:

- What is the appropriate methodology to undertake change process of DEA into Master?
- How could we plan and implement such change according to the National Development Plan 2015-2019 spirit and concept[10]?

Our hypotheses are:

- Engineering methodology is appropriate to process changing DEA into Master,
- Roadmapping Technology permits to plan and implement the change in line with the National Development Plan 2015-2019.

2. LITERATURE REVIEW

Roadmapping

Cosner et al.[2] defined TRM as a structured process for documenting the anticipated evolution of a company's markets and the product and technology development plans to address those future markets. So it is a system which integrates market, product and technology. In the present case, university could be assimilated as company. The university's market is the employment area.

The latter may be enterprises or public organization. Besides, the product is the lots of students propelled towards the market. And the technology may be knowledge or techniques and tools to conduct all activities. Galvin [] described the technology roadmap as an extended look at the future of a chosen field of inquiry composed from the collective knowledge and imagination of the brightest drivers of change in that field. This is an important point as far as the LMD reform is undertaken to assure a better future for students and the university itself. A roadmap can be defined as a map of presumed future and anticipated changes, comprising of illustrations of market trends, environmental changes, and technology life-cycles, linked together into tangible product line plans and considering the corporate objectives and competencies [11].

It can be said that Roadmapping is an open technology; it is used according to the user's ideas and concepts. What constitutes a roadmap and how to assess the effectiveness and efficiency of the roadmapping techniques employed rely on each user [8][12]. Phaal has identified more than 1,500 public domain roadmaps related to diverse domains such as science, technology, industry and policy such as: aerospace, astronomy, chemistry, construction, defense, earth sciences, electronics, energy, healthcare, manufacturing, physics, software, transport and other [12]. So, according to Phaal, roadmapping could be used for education concern, above all for how to plan it according to the National Development Plan 2015-2019 spirit and concept. It is a flexible and strategic tool. Kostoff and Schaller defined TRM as a consensus view or vision of future science and technology landscape available to decision makers. Winebrake [20]defined TRM as a future based strategic planning device that outlines the goals, barriers, strategies necessary for achieving a given vision of technological advancement and market penetrations. It endorses that TRM can be used to plan the LMD implementation. The following figure shows a typical form or TRM.

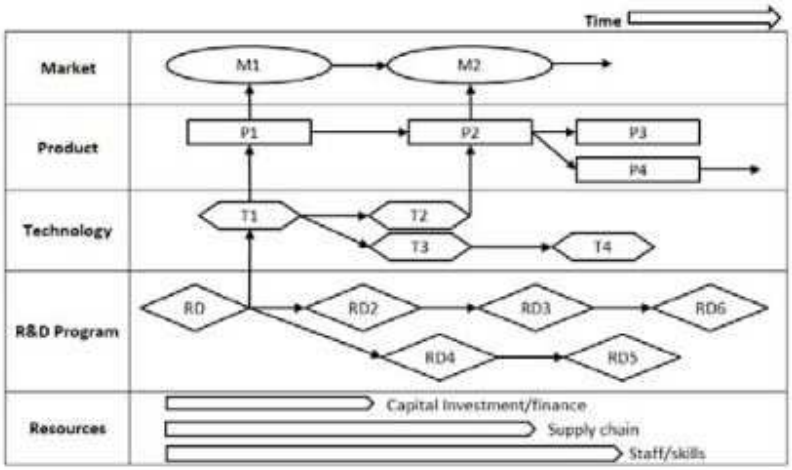

Figure 1: Typical Form of Technology Roadmapping (adapted from EIRMA [4])

The TRM starts with an analysis of market and its evolution. In the present survey, it is the employment market at national or international level. When the employment market is identified, the related product is detected. The Malagasy Government has detected the LMD as a central product.

3. METHODOLOGY

The following research process has been undertaken to change the DEA into Master of Science

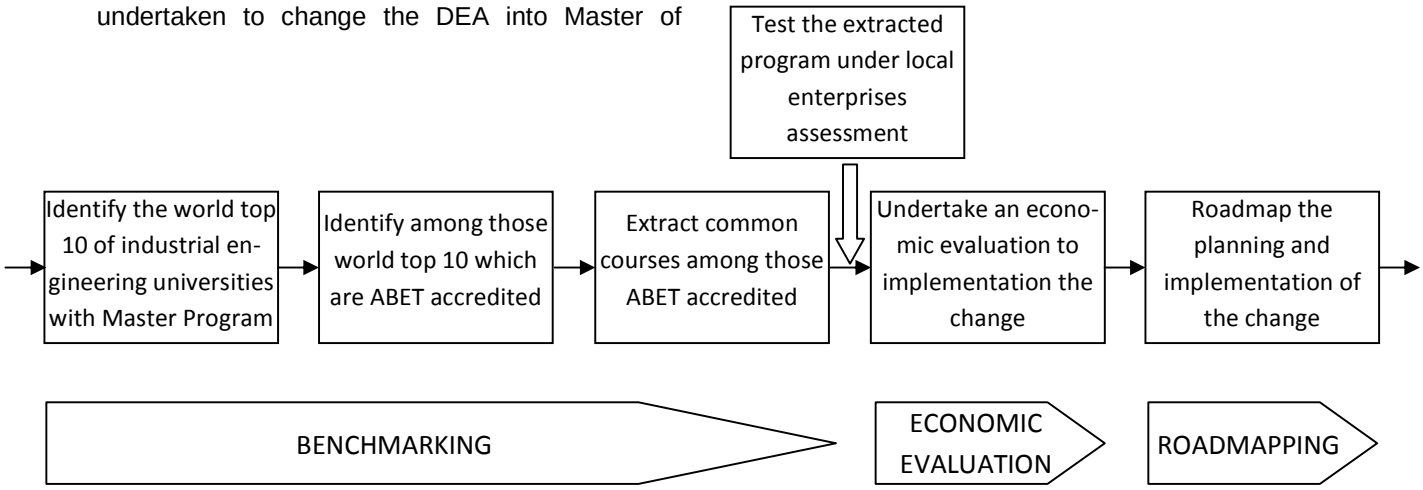

Figure 2: Research process to change DEA university education system to Master of Science

To identify the world top 10 of systems and industrial engineering universities, benchmarking is used. Benchmarking an industrial engineering theory to research-collect-analyze industrial information in order to identify the best and innovative practice Flynn [5]; Herring [7], Lackman et al.[9], Prescott et al. [13].

Then, the Accreditation Board of Engineering and Technology or ABET website is consulted. Originally, "ABET" stood for "the Accreditation Board for Engineering and Technology." The organization changed its name to simply "ABET" in 2005. ABET is recognized as the worldwide leader in assuring quality and stimulating innovation in applied science, computing, engineering, and engineering technology education. ABET serves the public globally through the promotion and advancement of education in applied science, computing, engineering, and engineering technology. ABET accredits educational programs, promotes quality and innovation in education, consults and assists in the development and advancement of education worldwide, communicates and collaborates with its constituents and the public, anticipates and prepares for the changing educational environment and the future needs of its constituents, manages its operations and resources in an effective and fiscally responsible manner. The research goal is to identify accredited systems and industrial engineering universities among the above top 10. Their master of science in systems and industrial engineering programs have been compared each other. The common program provided by those accredited universities has been extracted. The outcomes have been added to our project-engineering program.

According to an informal approach, the program has been tested under some local enterprises assessment to collect their comments and their inputs. The objective is to test the program relative to those enterprises' needs.

An economic evaluation is utilized to verify if research result is profitable. Economic model based on financial actualization model is performed. Then roadmapping is used for the planning and implementation of the change.

4. RESULTS

The following are the world top 10 universities with systems and industrial engineering programs.

Table 8: List of World Top 10 Universities with Systems and Industrial Engineering Program

Rank	Institution	Location	Overall score
1	California Institute of Technology	United States	94.4
2	Princeton University	United States	91.9
3	Massachusetts Institute of Technology	United States	91.4
4	University of California, Berkeley	United States	90.2
5	University of Cambridge	United Kingdom	89.4
5	Stanford University	United States	89.4
7	University of California, Los Angeles	United States	88.4
8	ETH Zürich – Swiss Federal Institute of Technology Zürich	Switzerland	86.1
9	Georgia Institute of Technology	United States	85.0
10	Imperial College London	United Kingdom	84.6

*Source: Extract from www.timeshighereducation.co.uk/**world-university-rankings/**, May 24, 2013*

Times Higher Education provides the above table concerning World University Rankings on Engineering. It is based on the evaluation of universities across all of their core missions, teaching, research, knowledge transfer and international outlook. The ranking employs carefully calibrated performance indicators to provide the most comprehensive and balanced comparisons available, which are trusted by students, academics, university leaders, industry and governments. It gives the overall scores

In the table, there are seven American universities. The first four are Americans, two are English universities and one is Swiss university. Only the seven American universities are accredited by ABET. They are shaded in grey. Their programs in systems and industrial engineering have been evaluated. And it is found that they have 27 common courses.

Table 9: Common Subjects to the Seven Accredited American Universities

Supply Chain and Logistic Engineering	Automated Manufacturing System
Special Problems in Industrial Engineering	Reliability and Safety Engineering
Discret Event Dynamic Systems	Occupational Biomechanics
Financial Engineering	Human Factors in System Design
Advanced Engineering Economic I	Economics and Dynamics of Project
Advanced Engineering Economic II	Risk Analysis and Mitigation
Enterprise Integration	Design of Experiments or Statistical Quality Control
Master Colloquium	Statistical Learning and Predicting Models
Industrial Engineering Colloquium	Statistical Learning and Data Mining
Dissertation	Six Sigma
Research Methodology	Systems Reliability Engineering
Simulation of Production Systems	Theory of Scheduling
Production Analysis	Production and Quality Engineering
	Manufacturing Information System

From the above program, some enterprises have been consulted. A discussion has permitted to verify if the program matches their needs. Subject identified with enterprises adds to our project-engineering subjects allow to obtain the following table. It contains three clusters of subjects.

Table 10: Subjects Suggested by some Local Enterprises and added to our Project Engineering Subjects

Malagasy Culture and Language
Strategic Intelligence and Global Culture
English for International Publication
Learning Factory
Elaboration for a Logic Frame and a Project Document
Planning of a Project
Economic Evaluation of a Project
Project Approach of Different Organisms
Project Simulation
Public Health Project Simulation
Electrification Project Simulation
Industrial Project Simulation
Public Works Project Simulation
Hydraulic Project Simulation

Local enterprises have proposed a subject named "Learning factory". Many teachers at the Ecole Supérieure Polytechnique also accept that subject. We have suggested new subjects such as "Malagasy Culture and Language", "Strategic Intelligence and Global Culture", and "English for International Publication". We have kept our ten subjects.

We have circulated the new program through facebook, linkedin and blogs during five months. The following needs are collected from such marketing process.

Table 11: Result of Marketing Process through Social Network

COUNTRY	FREQUENCY OF INTERESTED CUSTOMERS
KENYA	13
TANZANIA	11
SOUTH AFRICA	8
ETHIOPIA	7
RWANDA	7
TOTAL	**46**

The table shows that some 46 students from eastern African countries are interested in the master program. The majority are located in Kenya and Tanzania. In addition, we notice small quantity in Ethiopia and Rwanda. There are eight interested students in South Africa. Based on all those results, economic evaluation simulation, in US Dollar, has given the following spreadsheet.

Table 12: Return On Investment Simulation

ITEM	DATA	FORMULA	p=year1	p=year2	p=year3	p=year4	p=year5
Teaching Cost (TC)	input		50,000.00	50,000.00	50,000.00	50,000.00	50,000.00
Tuition Fee+Consulting Fee (F)	input		61,870.00	61,870.00	61,870.00	61,870.00	61,870.00
Cash Flow (CF)	calculate	(F-TC)	11,870.00	11,870.00	11,870.00	11,870.00	11,870.00
Return On Investment (ROI) or i	simulate	0.83	0.83	0.83	0.83	0.83	0.83
Conversion to Current Value Coefficient	calculate	1/(1+i)^p	0.55	0.30	0.16	0.09	0.05
Cash Flow Converted to Current Value	calculate	$CV*(CF)_p$	6,486.34	3,544.45	1,936.86	1,058.39	578.36
Cumulative CFCV	calculate		6,486.34	10,030.79	11,967.64	13,026.03	13,604.39
Investment	input	10,000					
Current Net Value	calculate		-3,513.66	30.79	1,967.64	3,026.03	3,604.39

In that simulation, there are fifteen foreigner students and fifteen Malagasy students. Respectively, they pay US$ 3,000 and US$ 458 per year. Besides, if we sell our service, it generates US$ 10,000 per year. Both give teaching cost and fee (tuition and consulting). We propose investment of US$ 10,000. The simulation period is five years.

The ROI takes value between 82% and 83% respectively for -US$ 3,513.00<Current Net Value<US$ 30.00 and -US$3,478.02<Current Net Value<US$ 105.48. Therefore, between the first year and the second one, the project begins to be profitable.

When the project is profitable, strategy to undertake its planning and implementation is elaborated. Technology Roadmapping is used and the following figure is obtained.

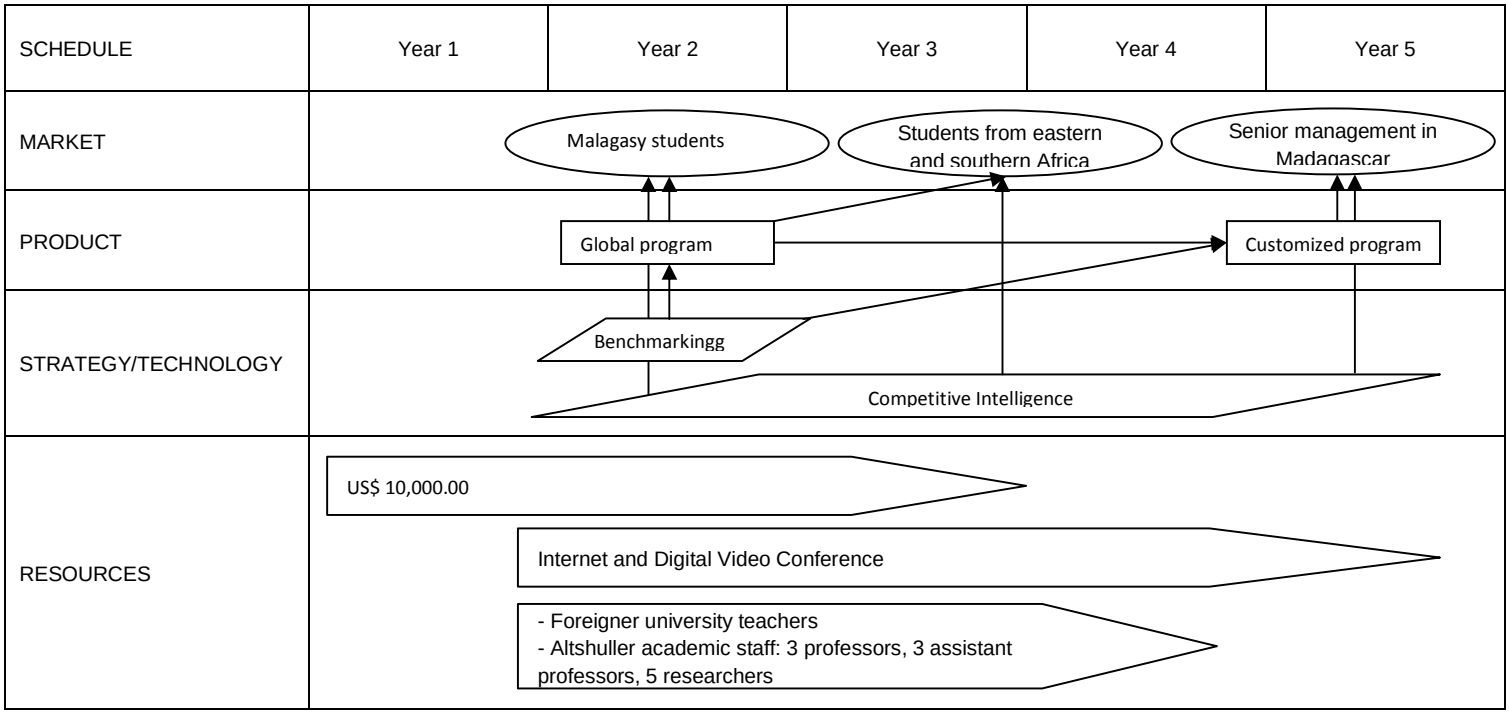

Figure 3: Technology Roadmapping for Changing DEA into Master

5. DISCUSSION

Our research has answered in affirmative that there is a research methodology, based on benchmarking, to conduct change of university education system into License-Master-Doctorate. Then, in terms of project, the change is profitable with ROI between 82% and 83%. And the project can be planned and implemented through a TRM in five years.

The first result is a new program in systems and industrial project engineering. It has two facets; it responds to the employment market, and it matches the needs in terms of quality of education. That new program permits all students to transfer one or more credits to other international universities. That process is known under transferability. It will make easier the mobility of every student.

The second result shows that the change into LMD is profitable for the university itself. The ROI confirms a significant rate. Then the TRM permits to identify the market situation. That market is measured by some number of foreigner students interested in the program.

6. CONCLUSION

That research methodology has permitted to target some world-accredited programs. In addition, it allows transferring at global level. Such methodology keeps on monitoring the progress of the change. That change has an information system supported by the four metrics of Skinner [6]. Therefore, we could control quality, flexibility, cost and delay on time.

We have sprayed the master program, obtained through our methodology, by the use of facebook and linkedin. Such marketing process has permitted to identify new segment of customers. Besides, it permits to appreciate our new program. Data from such marketing process are the inputs of the economic evaluation.

Our research has also answered that the research methodology and the research result, for the master program in the present case, can be implemented. They are in line with the main strategic orientations of development of the National Plan of Development 2015. Our results contribute to key sectors, as Small and Medium Enterprises/Small and Medium Industries and production sector with high employment creation. And our results are also in line with strategic axle of development of the supra National Plan of Development 2015 by delivering human capital for the development process. It concerns to establish an education system which matches the needs and international standards.

We can sell the results through consulting service to other public or private universities. We can coach the latter when they decide to process the change. Universities with industrial engineering program are concerned. Nevertheless, with benchmarking process, other universities with other programs could be concerned as well.

In addition, the program, through marketing process utilizing social network, can host foreigner students. That input increases the cash flow of the program and consequently improve the ROI yields 83%. The pay back of the investment is between 1 to 2 years.

The fruitful and profitable program should last to sustain the process. The Technology Roadmapping or TRM could sustain the profitability. In addition, such process could generate economic growth.

The TRM shows all key items to start and implement the process to change research product into sustainable economy. Each element shows the level of solutions identified through the Teoria Reshenia Izobretatelskih Zadatch or TRIZ according to Altshuller [7], Dourson [8], Rantanan et al.[9], Rea [10], Retseptor [11], Zhang et al.[12].

Innovations in that present study are new research methodology to change university education system into License-Master-Doctorate and research product that is a global master program in “systems and industrial project engineering”. Benchmarking or Competitive Intelligence has

played a determinant role in such research methodology.

Another innovation is the marketing process to make research result profitable. To perform that marketing process, we have utilized two social networks. Such process has identified a new group of customers. The corresponding results are key inputs in our economic evaluation process.

Economic evaluation process, to measure profitability of research methodology and research result, is also an innovation to show that research brings business opportunities. In such case, our study suggests Research and Business or R&B instead of R&D.

To start, develop, and sustain that business, our study proposes a business model [13]. An innovation in that business model construction is TRIZ. With TRIZ process, we have identified all keys points of the business model matrix.

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