



### Updated PhD Study Plan (11 Month)

**PhD Programme** : Department Of Development and Planning  
**Project title** : PBL model design and implementation at engineering institution in India: An alternative approach to meet industry relevant skills.  
**Name of PhD student** : Vikas V. Shinde  
**Education** : Master of Technology, Maintenance Engineering.  
**Institution** : Maulana Azad National Institute of Technology, Bhopal (India).  
**Academic supervisor** : Prof. Anette Kolmos  
**Co- supervisor** : Prof. Sandeep Inamdar  
**Department** : Department of Development and Planning.  
**Date of enrolment** : 1<sup>st</sup> September, 2010.  
**Expected date of Completion** : 31<sup>st</sup> June, 2013.

#### **Signature**

\_\_\_\_\_  
Date                      PhD student

\_\_\_\_\_  
Date                      Academic Supervisor                      Prof. Anette Kolmos  
Printed name

\_\_\_\_\_  
Date                      Academic Supervisor                      Prof. Sandeep Inamdar

\_\_\_\_\_  
Date                      Academic Supervisor                      Printed name

\_\_\_\_\_  
Date                      Head of Department                      Prof. Lars Bodum  
Printed name

\_\_\_\_\_  
Date                      Head of Department                      Prof. Andrew Jamison

\_\_\_\_\_  
Date                      Head of PhD program                      Printed name

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## 1. Project Summary

In most of the Indian engineering education institutions, instruction based pedagogy is practiced. The evaluation is based on the written examination in which students' ability to remember and reproduce the knowledge is tested. As a result the focus of the pedagogy is to facilitate the students to obtain good grades in these written examinations. The activities of the engineering students do not promote to develop higher order thinking skills and process skills. These observations are confirmed by the different national level studies [Goel & Sharda, 2004, Blom, 2010]. Hence, there is a need to find an alternative approach.

The past results indicated that, the Problem and Project Based Learning (PBL) approach promotes students for self-directed learning and to improve process competence. It is anticipated that the PBL approach could be useful for Indian context but, it has origin from western countries whose values are different from Indian. Hence, the objective of this research is to design a curriculum based on PBL approach by considering Indian context and to assess the impact of PBL implementation on students' learning outcomes.

This research will be carried on in two phases. During the first phase at Aalborg University (AAU), Denmark, it is proposed to conduct several field studies to gain the practical insight in the PBL model. The experience gained from the field studies and theoretical understanding gained from the literature will be used to guide the design of a PBL curriculum, which will be implemented at Sinhgad Indian Institute of Technology (SIT), India in second phase. It is intended to assess the impact of PBL implementation on Indian students learning outcomes. The student learning will be assessed by mapping a learning outcomes and their experience in PBL environment. The methodology used in this research is a design based research. The mixed methods research approach was used based on pragmatic paradigm. The data collected through various channels will be analyzed and presented as an outcome of the research.

## 2 Scientific Contents of the PhD Project

### 2. a Project Background

The current capacity of Indian engineering education system is capable to produce about 1.5 million engineers per annum. The privately owned (these are the institutions which get very little financial support from Indian government) institutes contribute almost 90% of this capacity. These institutions are affiliated to one of the state or central universities in India. This means that all the university affiliated institutions has to follow a common *curriculum* and *written examination* organized by that university (it could be noted that there are examples of a single university controlling 100 engineering institutions). It means that in each semester, as per the Bloom's Taxonomy students are tested for low level cognitive skills (remember, *understand and apply*) (Goel & Sharda, 2004) through these examinations.

Furthermore, the students higher level cognitive skills (analysis, *synthesis*, and *evaluation*) were tested only once during the final year major projects (with some exceptions twice, with mini project starting at the third year for some universities) of the four years of undergraduate studies. These reflections on engineering education are also stated in the reports published by Indian government [Yashpal, 2005, Knowledge commission, 2009] and reported in recent surveys [NASSCOM, 2011, Blom, 2010]. The above situation provides an excellent opportunity to inculcate appropriate changes in the curriculum design.

In the year 2008, Director of SIT visited Aalborg University and learnt about PBL approach. He realized that PBL could be an alternative approach, and need to be understood clearly. Through his realization the idea of this research is incepted. With a broad vision to contribute in to engineering education this research was started in 2010 ably supported by Sinhgad Technical Education Society, Pune and with the financial support through Erasmus Mundus Mobility for Life Project.

### 2. b A State-of-the-Art Based Introduction

#### Why focus on competence? International scenario

The world economy is becoming increasingly dynamic in view of changing customer needs and market trends. Globalization is pushing individual national economies to respond these market trends. As a result

engineering profession became much demanding than ever. The engineering profession no longer remained confined to its traditional disciplinary boundaries but became more complex and multidisciplinary in nature [Kolmos, 2006]. The industry demands range of professional, process and personal skills and can be found in recent surveys, Male [2011], Goel [2006], and Blom [2010]. These surveys indicated that ***the highest rated professional competencies are analysis/methodological skills, basic engineering proficiency, and problem solving skills. The communication, teamwork, and leadership skills are other important process competencies mentioned in these surveys.***

These demands put pressure on an education system to focus on skills and competence. Also, education systems are very keen to develop their graduates which are industry ready to take the employment in local and global workforce. To make amends to this situation, globally ***there is an inclination to design a curriculum with focus on competence development of an engineering graduate*** {Earnest [2001], Felder [2003], Dowling [2006], Caparoli [2008], Cameron [2009]}. It can be concluded that there is a ***growing need to focus on*** competence development and education system in India must provide an opportunities for competence development to engineering students. The importance of PBL in view of these trends is discussed in next section.

### Process competence development and learning in relation to PBL

Problem and Project Based Learning (PBL) can be defined as an instructional strategy in which students have to work with ill- structured contextualized problems and must make an effort to find meaningful solution. PBL encourages students to learn and work in teams. It also encourages students to learn about collaboration, different approaches to the problem, cooperation and responsibility [Rhem, 1998]. The PBL model for engineering education was first implemented at Aalborg University, Denmark in 1974 [Kolmos, 2004]. Empirical studies conducted at Aalborg University concluded that PBL helped students to gain ***process competencies. PBL environment provides ample learning opportunities*** in which students learn by cooperation, and collaboration with peers [Du, 2004, Shinde, 2011b]. Similar results are reported by Dochy, Faland, and Hansen [cited in Du, 2004].

PBL was found to be effective in ***developing and enhancing generic skills in students at*** University Technology, Malaysia (UTM). The results of the survey showed that ***generic skills of the 70% students had improved*** due to introduction of PBL [Yusof, 2005]. James Eck reported that, PBL is also having ‘***a positive impact on student learning***’ at Samford University, Birmingham. Research undertaken by four British Universities showed that well-structured project work ***can improve students' key transferable skills and information retention rate*** [Willmot].

The results of previous studies confirmed that there is a ‘***significant increase in the skills***’ and ‘***motivation towards learning***’ as a PBL environment provides range of learning spaces and opportunities to learn. ***This review strengthens the choice of PBL as an alternative approach for Indian engineering education.*** In the next section, status of PBL in India is discussed.

### PBL Status in India

Effectiveness of PBL instructions on knowledge and skills of the undergraduate engineering students at Chitkara institute of technology, Punjab was assessed over a period of four semesters. Results indicated that the students achieved better scores in knowledge and skill tests, showed better attitudes towards learning in PBL environment. Also, process skills were largely improved in the PBL class [Mantry, 2008]. Singh et al realized the impact of Robotic Competition on students of the Indian Institute of Technology (IIT) Delhi. He understood that the use of project helped students to understand aspects of product development, teamwork and project management [Singh, 2008].

Chattisgarh Swami Vivekanand Technical University, Bilai has started PBL in Bachelor degree courses of engineering and technology since 2008. Poornima group of Education, Rajasthan has a PBL Centre which organizes seminars and workshops related to PBL. PBL workshop series for middle school teachers of humanities science is regularly conducted by Homi Bhabha Centre for Science Education, Mumbai. The response through these seminars suggested that the major hurdles for implementing PBL in Indian schools include large class size, lack of teaching-learning resources and resistance to adopt new approaches. An important hurdle is a lack of guidance to teachers in conducting PBL research. Even though there are some

institutes where learning by doing or project oriented practice approach was used as a curriculum philosophy, PBL curriculum was never ever be designed and subjected to testing in India. In next section we will discuss guiding principles for design of PBL curriculum.

### Guiding Principles for PBL curriculum

Savin-Baden (2009) has outlined PBL curriculum into eight modes ranging from single module approach to institute level approach. The type of the models depends on the nature of problems. She proposed five models based on the objectives of the design. These models are for attainment of knowledge, for professional work, for interdisciplinary understanding, for cross discipline learning and for critical competence. The PBL curriculum can be designed by incorporating three learning principles referred by Kolmos as cognitive, contents and collaborative learning. Defining PBL in learning principles allows accommodating the local variations in the design. The design of PBL can be varied according to local culture, history of education and other several aspects of a particular country. PBL is an educational model can be designed at the course level (stand-alone model) or at a system level. The system level models are more organized and allow alignment for student centered learning [Kolmos, 2009].

The idea proposed by Savin-Baden and Kolmos highlights that while designing PBL curriculum it is important to decide the focus of curriculum and local context. Such decisions will help to guide the curriculum design. *The purpose of the proposed design is to focus on skill development.*

### Relevance of Project

Multiple studies indicated that for successful integration of PBL in different organizations, there *is a need to conduct research* with regards to **drivers and challenges** in the organizational change [Barneveld, 2009]. In this research, this issue will be addressed by analyzing drivers and barriers of PBL implementation in India.

By this research, a methodology to integrate PBL into existing curriculum will be developed with focus on skill development. Our efforts may motivate other institutes to integrate PBL and will serve as a symbolic framework for design, and implementation in India. Even though the world is weighing up positive results of PBL, Indian faculty has rarely experimented with PBL due to lack of literature, proper guidance and shortage of trained faculty. To facilitate future research, it is proposed to set up self-financing Centre for the Problem and Project Based Learning at SIT, India.

Finally, this research will contribute four research papers which will enrich the existing body of knowledge.

**2.c Project Objectives-**The objectives of the project are

1. To understand the PBL principles and practice in greater depth.
2. To assess the drivers, and challenges for PBL implementation in India.
3. To design a curriculum based on PBL approach for engineering education in India.
4. To assess the effect of PBL approach on students learning outcomes.
5. To assess the value gained by staff in PBL environment

Based on the objectives following main and subsidiary research questions are formulated

<b>Main Research Question</b>	<b>What are the implications of designing and implementating PBL model at Indian engineering institution?</b>
Subsidiary Research Questions	<ol style="list-style-type: none"> <li>1. <i>What are the drivers for a change from traditional teaching to PBL for Indian engineering education?</i></li> <li>2. <i>What are the barriers for the PBL model implementation at Indian Engineering</i></li> </ol>

	<p><i>Institution?</i></p> <p>3. <i>What does industry needs from engineering graduate?</i></p> <p>4. <i>What are the curriculum features of PBL model for an Indian engineering institution?</i></p> <p>5. <i>What is the effect of PBL on students' learning outcomes?</i></p>
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## 2.d Key Methods

It is understood from the preliminary literature review that PBL strategy has been developed in western culture whose values are different than that of Indian. Hence PBL model is to be designed for Indian context considering local constraints and culture. Such research features advocates design based research (DBR) methodology as informed by Confrey and Barab.

Contextual understanding is most important element in the DBR. This contextual understanding will help to understand the needs to be addressed by the design. Hence first three subsidiary questions are important as they will decide the basic structure of design.

In DBR, design is made to address contextual needs derived from previous stage; this will be addressed in 4<sup>th</sup> subsidiary question. In last stages of DBR design is subjected to test to find whether the design is worked or not. This will be addressed in 5<sup>th</sup> subsidiary question. Pilot study will be conducted for one year to collect the data to complete the PhD research.

DBR fortifies pragmatic philosophical worldview [Confrey and Barab]. Hence, this research falls in the category of pragmatic worldview with mixed methods research design. The qualitative methods mainly include focus group observations, semi-structured interviews and questionnaire with open ended questions. The quantitative methods mainly include Questionnaire and assessment reports.

In following section detailed procedure followed to address research questions is discussed in detail. Complete research project is divided in two main phases as shown in the following table.

	<b>Phase-A</b>		<b>Phase-B</b>
<b>Stages</b>	<b>Activities at AAU, Denmark Sept 2010 to Feb-2012.</b>	<b>Stages</b>	<b>Activities at SIT, India. March-2012 to Aug 2013</b>
A-1	Understanding the drivers for PBL implementation in India	B-1	Design of a PBL model.
A-2	Identifying the barriers for PBL implementation in India	B-2	Conducting Staff and student's Training
A-3	Identifying the needs of industry	B-3	Implementation and Assessing the impact of Design.

### Phase – A Activities at AAU, Denmark- Sept 2010 to Feb-2012.

The phase A is considered as a preparation phase utilized for contextual understanding for a PBL model design. The theoretical understanding and practical experience derived from this phase is a valuable input for a Design phase at SIT, India. Work done so far during this phase is listed in the following paragraphs.

#### A-1 Understanding the drivers of PBL

The First subsidiary research question *what are the drivers for a change from traditional teaching to PBL for Indian engineering education* was addressed primarily through existing literature from India and PBL related international publication. Indian literature mainly consists of National education reports and

employability surveys. These include Yashpal committee report, knowledge commission report, Rao Committee Report, NASSCOM survey, FICCI and World Bank survey.

## **A-2 Identifying the barriers for PBL implementation in India**

The second subsidiary research question *what are the barriers for the PBL model implementation at Indian Engineering Institution* is addressed through data collected through various sources as discussed below.

The qualitative data was collected during a workshop conducted in India in February 2011. The workshop on PBL facilitation and change management was conducted at Sinhgad University, Lonavala in March 2011. Perceptions on PBL model implementation of 160 Indian educators and administrators were recorded in the form of poster. The analysis of this data suggested that the Indian staff perceived PBL as a useful methodology to improve research and teaching-learning environment. They also perceived that considerable planning must be done and issues such as staff load, finance and other resources must be considered for successful implementation in India.

To get profound understanding of PBL process and practice, one semester field study was conducted on 7<sup>th</sup> semester mechanical students at Aalborg University from September 2010 to Feb 2011. During this study the qualitative and quantitative data were collected by various data collection methods. These mainly include questionnaire, periodic observations, the field notes and the semi-structured interviews. The data collected was analyzed. By this study group rooms, curriculum development and role of teachers are identified as some key issues for PBL implementation in India.

Thus data collected from workshop and field study along with the published international literature will be used to identify challenges of PBL implementation in India.

## **A-3 Identifying the needs of industry**

The third subsidiary research question *what does industry needs from engineering graduate* is addressed at this stage. The purpose of this research is to identify the skill demanded by the industry from graduate engineer to be successful in engineering profession. To identify the skills required from an engineering graduate, Indian and international skill surveys and reports were referred. It is concluded that industry demands (skill requirements from graduate engineers) are diverse in nature ranging from professional skills, process skills to personal skills. Based on this data skill set will be prepared. This skill set will act as a basic input for the PBL curriculum Design.

The design of proposed model should be such that during the four years of undergraduate studies engineering graduate must be exposed to the learning activities or situations in which he is gradually developing this skill set.

## **Phase – B Activities at SIT, India- March-2012 to Aug 2013**

During this phase of research most important activities are

### ***B-1 Design of PBL curriculum***

The fourth research question *what are the features of PBL model for an Indian engineering institution* will be addressed at this stage.

Firstly, the conceptual curriculum will be designed by studying the existing curriculum. Design of the conceptual curriculum will be guided by the understanding derived from the previous phase.

Also, the PBL principles and alignment model (Kolmos, 2009), PBL models (Savin-Baden, 2009), curriculum design principles (Tyler-1949, Taba-1962 cited in Smith-1996), and constructive alignment model (Biggs-1999) will be used as guiding principles for a design. The skill set identified from A-3 stage will be used to build a basic framework of PBL model. These skill set along with PBL activities will form a conceptual PBL curriculum.

To develop prototype PBL framework, conceptual design from previous stage will be put in front of the colleagues in the workshop. The basic philosophy and guiding principles will be explained to them. Also, this workshop will be used to get an input for the PBL model design and will be considered in design process. During this workshop the team of interested staff members will be formed and will be involved in design process. Prototype PBL model will be finalized by evaluating, modifying the conceptual design. During decision making process, decisions related to the structure, alignment and content of the courses, project related activities; assessment of learning outcomes will be made to form the prototype PBL model.

**B-2** Before implementation it is necessary to build a change strategy to lead the change from traditional teaching to PBL environment. The change strategy (Thousand and Villa, 1995) will be formulated with discussions with administrators and staff. Training needs for a staff and students will be identified in change strategy. Before actual implementation it will be made sure that staff and students are trained to work in PBL environment.

**B-3 Implementation and impact Assessment**

The fifth research question *what is the effect of PBL on students' learning outcomes?* will be addressed at this stage.

During implementation phase, an evidence based study will be conducted at Sinhgad institute of technology, India for one academic year at mechanical engineering department. The sample size is expected to be more than sixty with more than 12 groups of students. An assessment (formative and summative) tool will be developed to assess students learning outcomes. On this instrument, feedback and views of students will be recorded. Other methods for data collection include field notes, work diary of participants. At the end of the study semi-structured interviews of supervisors, observers and few students will be conducted. Staffs' experience will also be gathered by data collection methods as discussed above. A systematic data analysis will be done to address the research question.

**e Experience and results obtained so far**

Till date, I have completed 27 ECTS by attending PhD courses and conferences. Three workshops, one international conference and a seminar were attended for knowledge assimilation. To get the deep insight into PBL, one semester field study was conducted at Aalborg University. This phase was also used to design instrument for data collection and to write three conference papers.

Three days staff development workshop was conducted at Sinhgad University, Lonavala in March 2011.

The literature review on PBL models was completed. The purpose this review was to understand the different PBL models practiced in the world. Also, a literature review to identify drivers and challenges of PBL implementation in India and a literature review to identify the skills demanded by the Indian and the international industries from an engineering graduate was completed.

**Project's Expected Outcome (methodological contributions)**

1. Design of a curriculum based on PBL approach.
2. Design of instrument to assess students learning outcomes.
3. Students and staff's reflections on PBL model.
4. Change strategy for PBL implementation in India.
5. Three conference and three journal papers.

**2.f. Time Schedule**

PHASE	PHASE 1 at AAU						PHASE 2 SIT, INDIA					
	Year 2010		Year 2011				Year 2012				Year 2013	
	Sept -Oct	Nov-Dec	Jan-Mar	Apr-June	July-Sept	Oct-Dec	Jan-Mar	April -June	July-Sept	Oct-Dec	Jan-Mar	Apr-June
Problem												

formulation												
Literature Review												
Design of PBL model												
Experiments, Field studies												
PhD courses												
Publication, Knowledge dissimilation			IC-1		IC-2	IC-3 JP-1	Training		JP-2		JP-3	
Thesis Writing												
Study in AAU												PD
Interaction with practitioners												

IC-International conference, JP-Journal Paper, PD-PhD Defense.

#### Plan of milestones

Month	Milestone
2	Submission of 2 months study plan.
6	Instrument design and completion of case study. Workshop in India and first Conference paper
11	Two more Conference papers, Submission of 11 months study plan.
18	Completion of writing first journal paper.
24	Staff and Student's training, Complete Design of PBL curriculum & start writing second journal paper.
30	Start writing of 3rd <sup>h</sup> journal paper and start writing the thesis.
34	Final Assessment of model Finish writing of thesis.

**2. g Outline of Thesis-**The PhD thesis is to be documented as a plurality of articles and chapters. It also include short summary of 30 pages covering an overview of the research and significant scientific achievements.

Ch-1	An overview of the research.	30 pages
Ch-2	PBL related literature Review	20 pages
Ch-3	Future engineer –reflections on skills and competence.	20 pages
1.	PBL in engineering education in India: Drivers & Challenges	Conference Paper
2.	Students' experiences of Aalborg PBL model: A case study.	Conference Paper
3.	Relevance of PBL in Indian engineering education	Conference Paper
4.	Investigating the concerns of PBL implementation in Indian Engineering education.	Journal Paper
Ch-4	Development of Engineering Curriculum by Integrating PBL approach: Reflections on curriculum development Process	20 Pages
5.	Integrating PBL approach to Engineering Curriculum to bridge the skill gap of Indian Engineers.	Journal Paper
6.	Is PBL better way to learn engineering? Indian staff's and Students' Voice	Journal Paper
Ch- 5	Results and conclusions	20 pages

#### 2.h Publication strategy

Title of paper	Co-author(s)	Name and place	Time of
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			<b>submission</b>
PBL in engineering education in India: Drivers & Challenges	Anette Kolmos	International conference, Chennai.	28 <sup>th</sup> Feb-3 <sup>rd</sup> March-2011
Students' experiences of Aalborg PBL model: A case study.	Anette Kolmos	SEFI Annual Conference, Lisbon.	28-30/09/2011
Relevance of PBL in Indian engineering education: Perspective	-	3rd International Symposium on PBL Coventry.	28- 29/11/2011
Investigating the concerns of PBL implementation in Indian Engineering education.	Anette Kolmos, Erik De Graff Claus Spliid Chung fang	Journal Paper	Dec 2011
Integrating PBL approach to Engineering Curriculum to bridge the skill gap of Indian Engineers.	Anette Kolmos, Sandeep Inamdar	Journal Paper	Dec-2012
Is PBL better way to learn engineering? Indian staff's and Students' Voice	Anette Kolmos, Sandeep Inamdar	Journal Paper	May- 2013

### 3. Agreement between Vikas Shinde (VS), Prof. Anette Kolmos (AK) and Prof. Sandeep Inamdar (SI)

VS is the prime responsible for the project, AK and SI is responsible for supervision. VS will be responsible for time management in the project. When VS is staying at Aalborg University, VS will work full time on the project, while AK will spend an average 6 hours per month on the project. AK and SI will provide feedback whenever needed. Meetings between VS and AK,SI will be conducted regularly approximately once every second week, with the possibility to conduct meetings as needed. In the meetings all topics related to the current activities and the project in general can be discussed. At the end of each meeting, AK,SI and VS will work the plan until the next meeting.

When VS is situated at SIT, Lonavala, he will stay in touch with AK through email and video conference. AK expects every fortnight a short notice on the progress of VS. Also, SI will closely monitor the progress while VS is at SIT. It is expected that VS participates in a sufficient number of PhD courses workshop, and seminars during the project period. AK and SI will support VS in building his professional network. The project is addressing very relevant subject where only little work has previously been done in INDIA. It is therefore expected that at least 3 conference papers & 3 journal papers can be published. These publications along with the various surveys to be conducted will provide the basis for the final thesis. Every 6 months, AK, SI and VS will discuss the potential needs for updating the agreement. In case of misunderstanding or conflicts, AK, SI as well as VS is free to contact the department or the research school for help.

### 4. Plan for PhD Courses

**Table 2 Plan of PhD Courses**

Name of the Course	Place/ Organizer	ECTS	Status
<b>Project Courses</b>			
PBL and supervisory skills	AAU/Prof. Lars Peter Jensen	2	Completed
PBL & Engineering education research- from research questions to research methodologies & publications	AAU/ Prof. Anette Kolmos Prof. Erik de Graff	4	Completed
Introduction to qualitative research in technology, science and education	AAU/Prof. Tim Richardson, AAU/Prof. Paola Valero	3	Completed
Study Circle Meetings	AAU/ Prof. Anette Kolmos	2	Completed
	<b>Sub-total</b>	<b>11</b>	
<b>General Courses</b>			

Professional communication	AAU/Prof. Anette Kolmos	2.5	Completed
Modeling the Dynamics of wind generating systems	AAU/	4	Completed
Writing & Reviewing Scientific Papers	AAU/Prof. Jakob Stoustrup	3.75	Completed
Preparation of research plan for PhDs	AAU/Prof. Frede Blaabjerg	1	Completed
Bayesian Statistics, Simulation and Software With A View To Application Examples	AAU/Prof. Søren L. Buhl	3	Completed
Theories of science	AAU/Ole Ravn Christensen	2.5	Planned
	<b>Sub-total</b>	<b>16.75</b>	
<b>Conference Papers</b>			
PBL in engineering education in India: Prospects & Challenges	Chennai, India	2	Completed
Students' experience of Aalborg PBL model	SEFI, Lisbon	2	Paper accepted
Relevance of PBL model to Indian engineering education : literature review	Coventry University, UK.	2	Paper accepted
	<b>Sub-total</b>	6	
	<b>Total ECTS</b>	<b>33.75</b>	

**5. Plan for dissemination of knowledge and findings from the project-**During my stay in India, One short term training program on a PBL will be conducted for the students and faculty.

**6. Agreements on Immaterial Rights to Patents-**The outcome of the research work will be registered for IPR (if applicable).

**7. Plans for external collaboration-**It is planned to work along with practitioners at Sinhgad Institute of Technology, Lonavala, India and in consultation with Indian supervisor.

**8. Financial budgets for PhD project-** This research is funded by Erasmus Mundus Mobility for life project in which I receive scholarship @1500 euro per month during stay at Aalborg, Denmark.

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