The Essentiality of Sustainability and Variety for Industry Collaborations with University Partners

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Abstract—Industry and university collaboration benefits both parts. Companies like small and medium-sized enterprises (SMEs) appraise the industry assigned student projects with university partners as a resourced input to their daily tasks. This paper summarized a cased university college´s collaboration with business communities through the bachelor projects over last 10 years, and analyzed the performance mechanism on industry assigned student projects. Such a project is a real world approach, benefits both engineering colleges and business communities. The projects usually start with real problems or needs presenting by the companies then assigned as project tasks to the students. The companies get tasks done and the students learn the real world through the projects. The analysis shows a sustainable collaboration occurs only with few large size companies. They usually involved in many student projects over many years. However, the majority of the college´s industrial partners, thus small and medium-sized enterprises (SMEs) assigned only no more than two projects per company then drop off. We question and discuss the essentiality of sustainability performance for industry assigned student projects and necessity of contributions and engagement by companies.

1 Introduction

As global economy is increasing, the collaboration between industry and engineering universities plays a vital role for professional higher education, preparing students to meet a real and variable world in the future [5]. Many companies appraise universities as a positively sourced input. Many universities and college are collaborating with industries and adopting industrial assigned student projects into their educational programs. Early study [10] also showed most of students´ experienced better learning outcomes in terms of applying knowledge from one course to the others and seeing an entire picture of knowledge base. Others even more direct targeting the education programs directly toward profession job matching or job creating [7], or focusing on the real world integrating into the regular study curriculum [3]. Though some study

[4] pointed out challengeable barriers, as poor communication, different priorities and lack of resources lack of a clear, convenient, coordinated system of contact in and across universities and potential industrial partners. There are also successful cases as industrial and academic platform [1] where the industry partners contribute with low risk with product ideas, where multidisciplinary student teams meet those ideas in projects, with their own innovative proposals and prototyping [2].

It is therefore interests and beneficial to study how industrial assigned student projects perform at the college study programs, and how performance affects industrial and academic collaboration, as well as what benefits the industrial partners, especially SMEs receiving from these projects.

Østfold University College (OUC) is a public and accredited university college with multiple professional disciplines, as engineers, nurses, bookkeepers, etc. OUC is also regional services based higher education institution focusing on sustainable collaboration with local industries and business communities. The region´s high population density, variety of industries and transport infrastructure facilities provide a good access for OUC to many business companies. This access benefits OUC to adopt real problem based teaching methods into practices. The industry and local business communities need what we called Day One (works as an employee from day one employed) engineers, nurses or bookkeepers to the job tasks right after their graduations.

OUC, Faculty of Engineering has an advantage and a long tradition to collaborate with local industrial partners. There are 22 000 registered companies in this region, mostly Small and Medium-sized Enterprises (SMEs), though some large corporates, but all have easy accesses connecting less than 2 hours driving distance each other. This counts as an OUC´s geographically competitive advantage in collaborating with local business partners.

For past 20 years, one of OUC´s industry collaboration actions is industrial assigned student bachelor (or capstone) project assignments. Such bachelor projects are mostly independent and open for a large variety, but to some extent, targeting to student research actions. The bachelor projects are organizing normally in groups where each group has 3-4 students to do the project task jointly. There are annually 50-70 such student groups doing the bachelor projects with mostly industrial assigned student projects. For 2017, there are total 67 such student projects, and 62 assigned by external actors [6], either by business companies or public organizations outside of the university college.

In most cases, the students have their freedom to organize their project group and select the industrial assigned project they prefer to committee with. The selecting process is based on the student groups interests combined their professional backgrounds. A typical student project can be as creating and conducting a survey, an analysis, a design or a concept or prototype for the assignment upon the real problem the assigned company sketched for them. Through these tasks, the students will obtain the real world experiences and problem solving skills.

For year, the students, the university college and the industrial partners all appreciated much industrial assigned student projects and their benefits to all partners. However, such student projects have a great variety in practical performance, depending

on topics, company and student engagements, the complexity, content and expectations for each project. Such project outcomes and processes are more dynamic and less standardized when compared with regular classroom lectures, so there is a need analysis the project performance systematically and identifying sustainable elements.

2   The research questions

Our past 20 years of experiences with industrial collaboration shows that even industrial partners and university colleges can see the industrial assigned student projects are good and beneficial contributions for both, there are challengeable elements both sides need to work with.

The students have experienced a great variety of how a company or an industrial partner contributed such an industrial assigned student project. Some companies are good contributors to the student project assignments with clearly defined assignments and assigned with company mentors/coordinators to coach the students, while for other cases the students can experience lack of real interests and unwillingness from the company, but only demands the results from the students without contributing coach and further discussions. As a result, students was leftover and project was not reaching the expectation.

This leads to our research questions: Can we find a sustainable model or mechanism for industry collaboration to last and benefit both parts in a long term? What are the basic structure and mechanism for such model? Is there any difference among companies for their interests and engagement for the university college student assigned projects? How can we utilize these differences to our best benefits for both sides?

We look at OUC statistic overview over 20 years´ data base for final engineering bachelor student projects, including industrial assigned projects, but also all other types as well.

3   The data materials, statistics, results and discussions

The data collecting was all registered bachelor student projects at OUC, faculty of engineering dated in 2006-2014. There are totally 1060 engineering students conducted their bachelor projects during the period, for most cases, 3-4 students organizing into one project group with one project assignment. Majority projects assigned by industrial partners but some also with own and initiative topics, or assigned by OUC colleagues as a part of research projects.

There are 167 companies contributed totally 293 topics or assigned student projects for the period. Table 1 shows the total number of industrial assigned projects for the whole period, combined with frequency on reappearance of the same company reassigned or repeat student projects over the period.

Table 1. Frequency on reappearance of the same company contributing student projects

Company assigned projects	Number of companies	%	Number of projects	%
Assigned only 1 time	129	77,25 %	128	43,69 %
Assigned 2-4 times	24	14,37 %	54	18,43 %
Actively Assigned 4 times and more	14	8,38 %	111	37,88 %
Total	167	100,00 %	293	100,00 %

Accounting frequency on reappearance of the same company repeatedly contributed student projects shows the following trends:

14 companies contributed more than 4 times, while 24 companies contributed moderate, thus 2-4 times to the student project assignments. There are 129 companies appeared only once and not come back. We can conclude most companies are coming and going attitudes for this kind of collaboration. Thus, there is a great improvement potential for many companies.

A detailed overview over the most active 14 companies contribute totally 111 industrial assigned student projects, see table 2, indicates their business categories are even concentrated in fewer sectors, processing industries, consulting energy supply, manufacturing, and public services, ete…...these categories are mainly representing the region´s business features and large companies [9].

Still, OUC with 26 student projects is the largest single contributor for the student projects, means OUC academic student projects exceed any company contribution solely over the years. This category includes OUC staff research topics and student own initiative projects, such as car competition projects for instance.

Table 3 shows the annual statistics for industrial assigned student projects. It is variable from a company to another. However, total annual student projects have an increasing developing trend, except 2014 when OUC dominated the statistics by 9 student own initiative projects.

Another observation on table 3 indicates there is an advantage to have many industrial partners in the same category, so the university college can assig industrial assigned student projects with more than one company. As case of chemical processing, the company ID11 compensated the lack of project in 2013 with 2 projects when company ID1 did have any project to contribute. So did manufacturing case as company ID13 contributed project in 2009 and 2010 to compensated missing space left by company ID10.

The dynamics and frequency on single company´s project contribution also shows a trend that for many companies need also a break or vacancy away for student project, except some company might keep this continuing, as company ID9 since 2008 and public service ID14 since 2009.

Another fact is, the majority of companies on the list are mostly large companies with over 500 employers, so collaboration with these companies are first of all approved by the university and company´s top management. The collaboration is targeting for a long term and a sustainable perspective, indicates a fact that once collaboration starts, it is relatively easy to follow up and continue further steps.

Table 2. An overview over 14 most active industrial companies assigned projects

Active company ID	Active company categories	Number of Project contributed	% on the most active organization	% across organization all categories
1	Chemical processing	5	4,50 %	1,71 %
2	Construction engineering	4	3,60 %	1,37 %
3	Engineering consulting	11	9,91 %	3,75 %
4	Energy supply	4	3,60 %	1,37 %
5	Public services	6	5,41 %	2,05 %
6	Engineering consulting	4	3,60 %	1,37 %
7	University college	26	23,42 %	8,87 %
8	Energy research	5	4,50 %	1,71 %
9	Engineering Consulting	9	8,11 %	3,07 %
10	Manufacturing	13	11,71 %	4,44 %
11	Chemical processing	4	3,60 %	1,37 %
12	Energy supply	4	3,60 %	1,37 %
13	Manufacturing	4	3,60 %	1,37 %
14	Public services	12	10,81 %	4,10 %
	Sum project contributed by Active company	111	100,00 %	37,88 %
	Grand Total	293		100,00 %

Table 3. Annual statistics for industrial assigned student projects

Active company ID	Active company categories	2007	2008	2009	2010	2011	2012	2013	2014	Total
1	Chemical processing		1	2			1		1	5
2	Construction engineering	1	1			1				4
3	Engineering consulting	2		2	3		2	1		11
4	Energy supply				1	1	1	1		4
5	Public services			2		1		1	2	6
6	Engineering consulting					1		2	1	4
7	University college	3	1	1	2	3		4	9	26
8	Energy research		2	1				1	1	5
9	Engineering Consulting		1	2	1	1	1	1	2	9
10	Manufacturing		1			1	4	2	2	13
11	Chemical processing						1	2		4
12	Energy supply	1				1	2			4
13	Manufacturing		1	1	1					4
14	Public services			1	3	3	2	1	2	12
	Sum project contributed by Active company	7	8	12	11	13	14	16	20	111
	Grand Total									

OUC has standard engineering study disciplines and these disciplines are dividing by traditional engineering disciplines. One challengeable task for higher education is how traditional disciplinary study programs matching the growing and changing job market and industrial restructuring, that creating new job and new professions. Table 4 shows industry assigned student projects over different engineering related study disciplines. As the following coding:

Table 4. Industrial assigned student projects distributing over study disciplines

Active company ID	Active company categories	CE	IP	CE	EE	ME	ID	Total
1	Chemical processing			4		1		5
2	Construction engineering	4						4
3	Engineering consulting	7			4			11
4	Energy supply				4			4
5	Public services	5	1					6
6	Engineering consulting	3			1			4
7	University college	3	3	2	12	2	4	26
8	Energy research					1	4	5
9	Engineering Consulting	9						9
10	Manufacturing			1	7	5		13
11	Chemical processing		1	2		1		4
12	Energy supply				4			4
13	Manufacturing		2		1		1	4
14	Public services	12						12
	Sum project contributed by Active company	43	7	9	33	10	9	111
	Grand Total							

- CE - Civil engineering
- IP - Innovation and project management
- CE - Chemical engineering
- EE - Electronics engineering and power electricity
- ME - Mechanic engineering
- ID - Industrial design engineering.

We noticed, on table 4, illustrating student projects distributing over different disciplines, that CE (43), EE (33) and ME (10) had most projects, and this concentration had same professional disciplines as most industrial partners are CE (construction engineering, or engineering consulting), EE (energy supply) and ME (manufacturing). These are the traditionally and heavily engaged industries in this region.

Table 5. Grades frequency on student projects assigned by companies and the university

Active company ID	Active company categories	A	B	C	D	E	Total projects
1	Chemical processing		1	4			5
2	Construction engineering	2	2				4
3	Engineering consulting	2	4	5			11
4	Energy supply		1	3			4
5	Public services	1	3	2			6
6	Engineering consulting		3	1			4
7	University college	1	10	10	5		26
8	Energy research	2	2	1			5
9	Engineering Consulting	2	7				9
10	Manufacturing	1	8	4			13
11	Chemical processing	2	1	1			4
12	Energy supply		3	1			4
13	Manufacturing	1	2	1			4
14	Public services		4	7	1		12
	Sum projects each grading category	14	51	40	6	0	111
	Percentage total	12,61%	45,95%	36,04%	5,41%	0	100

This is a good and accurate picture for ongoing business structure for the region, as the major business companies are still active in these fields. The companies have many contracts and tasks and are willing to direct some tasks or feasibility studies for near future tasks to the college students. While at the same time, the companies are able to check the students´ competence and abilities into future potential employment with the companies without risking too much through a recruiting process.

There has been another ongoing trend to show an increasing need for cross-disciplinary competence combined with two or more traditional study programs. A further dividing on the information on grades distribution over the university college´s different study programs, from table 5, creating of a summary on cross-disciplinary projects, showing on table 6, by marking the student project categories different from the company categories.

Table 6. Grades frequency on cross-disciplinary student projects assigned by companies

Active company ID	Active company categories	CE	IP	CE	EE	ME	ID	Total
1	Chemical processing			4		1		5
10	Manufacturing			1	7	5		13
11	Chemical processing		1	2		1		4

As we can see, the chemical processing company ID1 and ID11 not only assigned student projects for CE, but also for ME, and IP as well. Same trend shows ID10 assigned CE and EE projects in addition to ME projects.

The phenomena confirmed a growing trend, that future industries need more cross-disciplinary competence and engineering candidates whom can learn and work not only with own academic backgrounds but also new and other fields as well. Purely dividing and functioning of professional disciplines is outdating approach and will see less and less both in real business world. Implementing CDIO into academic curriculum and student projects are the best approach.

We also observed the student project grades among these 14 active project contributors. Table 5 shows an overview over of the frequency of student projects for each grades over each company assignment. Early studies claimed the company assigned student project might get better grades than university academic projects. For our study, we observed generally grades are concentrated within A, B, C, especially B and C, independent topics and assignments. Few Ds within university college projects and public services, but no one even gets E.

For the project evaluation grades, the Norwegian grades system refers the national standards by Norwegian Agency for Quality Assurance in Education and defines the grades as (expresses as popular terms):

- Excellent (best);
- Very good (good);
- Good (average);
- Weak or missing major element (weak);
- Just passed minimum requirement (poor).
- Failed (terrible result)

From table 5 we can see there are almost equally distributions for grades B and C for university college assigned projects, while the industrial assigned student projects have overweight B and A grades. On the other hand, the majority of students pay more attention for their bachelor thesis no matter where their assignments come from, so this might lift up the general grades level for this category of evaluations.

Table 7. Grades frequency on student projects assigned by companies and the university

	Total 85 industrial projects			
Grades	*A*	*B*	*C*	*D*
Frequency grades	13	41	30	1
Projects each category	85	85	85	85
Percentage grades	15,29 %	48,24 %	35,29 %	1,18 %
	Total 26 academic projects			
Grades	*A*	*B*	*C*	*D*
Frequency grades	1	10	10	5
Projectseach category	26	26	26	26
Percentage grades	3,85 %	38,46 %	38,46 %	19,23 %

A further grades comparing is showing on table 7, where two categories grades, industrial assigned projects (85=111-26) versus university academic assigned student projects (26) are separate but also compared each other.

According to the percentage of each grades within the same category on table 4, we conclude that the industrial assigned projects had higher percentage and perform better than academic in grades of A and B. While for average and weak grades C and D, the academic assigned student projects had larger percentage and more represented.

4   Conclusions and final remarks

Summarizing the statistics overviews and data analysis, we can conclude the following remarks for industrial assigned student projects:

- The industrial partners´ sizes and professional categories are essential for sustainable industry collaboration. Large companies might have more resources to follow up and able continue collaboration often request after first student project. Small companies tend to be coming and going partners, most cases, engaged only once for a student project.
- The few major large size companies dominate the majority of assignments for the student projects. This is good for stability and continual collaboration, but not good for project diversification.
- It is beneficial to have many companies, even within the same professional disciplines. This can also secure the sustainable student project supplying when one company takes a break while another company steps in.
- Industry assigned student projects have better performance than academic projects in larger percentage of grades of A, B categories, and less C, D categories in grades.
- The traditional engineering disciplines such as CE, EE, ME has more industry assigned student projects than other disciplines. This concentration is matching with local industry profile in the region, which is traditionally CE, EE and ME based.

Responding the research questions asked in early part of the article, we suggest to keep broad company contact network, but focus on few larger companies, might be a sustainable model for industry collaboration that lasts and benefits both parts in a long term. Once the collaboration established, the larger companies are most likely with commitment, and contributed with necessary resources.

The industrial collaboration experiences indicate that the contacts and actions must be on operative levels, not only at the management level. Timing is a critical issue, as the industries need such assigned student projects anytime, while the university college only provides certain time windows for taking such project inquiry. Planning, timing and communicating are the key elements.

Large companies are most likely looking for a long-term contact establishing with university colleges and are able to contribute with multidisciplinary student projects.

Small companies are likely focusing on particular tasks or needs, so they want to results and might easily be coming and going partners.

However, a complex industrial and academic collaboration needs multiplex actors and companies. Large, small and SMEs are all good contributors in their ways. A constant changing market and growing competition leads the industries restructuring frequently. Therefore, the industrial assigned student projects also need a great variety of choices, contributed by different companies, particularly good and sustainable contributions by SMEs.

SMEs need to learn and getting familiar with university system, rhythms and routines in order to be sustainable. At the same time, SMEs are great contributions in variety since many SMEs operate in different branches and sectors, even generate a network or a supply demanding chain is sustainable and variable.

The universities and colleges staff need also to learn the companies, especially SMEs needs and their languages to understand and listen their needs and daily tasks. This will be the essential step to reach the industrial partners, particularly SMEs to aim a successful collaboration.

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