Research & Innovation Unit

Industry-Academia Collaboration in Nepal

A case study of detailed feasibility of Reinforced Suspension Preheater in Udayapur Cement Industry

Sojan Prajapati, Sanjay Mahat, Suraj Poudel, Alish Shrestha, Dipesh Mishra, Tika Kunwar

October 2021

Research & Innovation Unit

Industry-Academia Collaboration in Nepal

A Case Study Of Detailed Feasibility Of Reinforced Suspension Preheater In Udayapur Cement Industry

Overview

The Need :
Students lack experience in large-scale projects that they are expected to face after graduation.

The solution:
Udayapur project has acted as a milestone in achieving the industry-academia ecosystem.

The benefit:
Students get hands-on industry experience and industries get benefitted from it as it strengthens the company's research and development programs.

Technologies are evolving faster than ever. Industry implementation at the same pace is difficult. Almost all of the innovations are connected to university research in one way or the other. However, the downside of the university approach is the research is mostly limited to paper. To bridge this gap, industry-academia collaboration is needed.

Status Quo of Industry-academia collaboration in Nepal

Industry-academia collaboration is relatively a new concept in Nepal. Kathmandu University has been constantly trying to implement industry internships, thesis, and co-publishing papers with industry. Few attempts have been done by Tribhuwan University and others however it has not been a huge success due to outdated curriculum, tight schedule. Even from the side of the industry, there have been very few attempts to actively participate in the collaboration with the academia. As a result, academic institutions are producing students that have different sets of skills than required in the industry.

Typically, the collaboration relationship can be of four stages[CII]. Since one of the members of our team already had the experience of some years at UCIL, we were already into the first stage of getting to know each other. For the second stage of light touch interactions, formal and informal meetings of the UCIL and acem team took place which was mainly focused on drawing road maps for the deeper interactions based on the common interests. For the third stage of the deeper engagements, understanding between both parties was made regarding the modality of their relationship. For the fourth stage, a team from acem will be undertaking several projects at UCIL along with the UCIL team. This paper only describes one of the research problems of the first project of the acem team at UCIL as a case study.

Research & Innovation Unit

> *“Make no mistake about it: producing cement in Nepal is a difficult task. Wedged between two giant neighbours, India and China, this landlocked country offers cement producers a long list of challenges – from the availability and quality of raw materials to the supply of fuel and skilled labour.*
>
> *-FL smidth*

Literature Review

The number of cement industries in Nepal is rapidly increasing, as 48 cement industries were registered between 2004 and 2014, out of a total of 77 cement industries registered. Specific electrical energy consumption of cement industries in Nepal is 148.56 kWh/T of cement and the specific thermal energy consumption is 5.411 MJ/kg of clinker, which is higher than the average values of the rest of the world[1].

There were 114 cement industries registered at the Department of Industry(DOI) till 2018. Among them, only 65 industries have taken National Standards(NS). The industries listed in NS are in operation and a few are under the process of operation. The past historical data of demand shows that demand for cement is increasing steadily with mounting demand on generating sectors. The 58 industries were registered in the period of 2068-2075 alone which is more than 50 percent of the total industries registered[2].

Udayapur Cement Industry with a production capacity of 800 metric tons per day, is the biggest cement factory in Nepal located at Jaljale, Udayapur which is 200km far from Jogbani, India Border. It was established on 31 Jestha,2044 (14th June 1987). Udayapur Cement sells products under the brand name of "Gaida Cement", one of the best in Nepal, and is known for its quality and strength[3].

Objective of the collaboration

UCIL is the oldest cement factory in Nepal which finished its construction in 1987 with the help of Consulting Engineers from Onoda Engineering Co. Ltd., Japan. The factory has been running at the maximum capacity of 800 tons per day (TPD) clinker production. The company has been planning for the up-gradation of the factory up to 1100 TPD capacity.

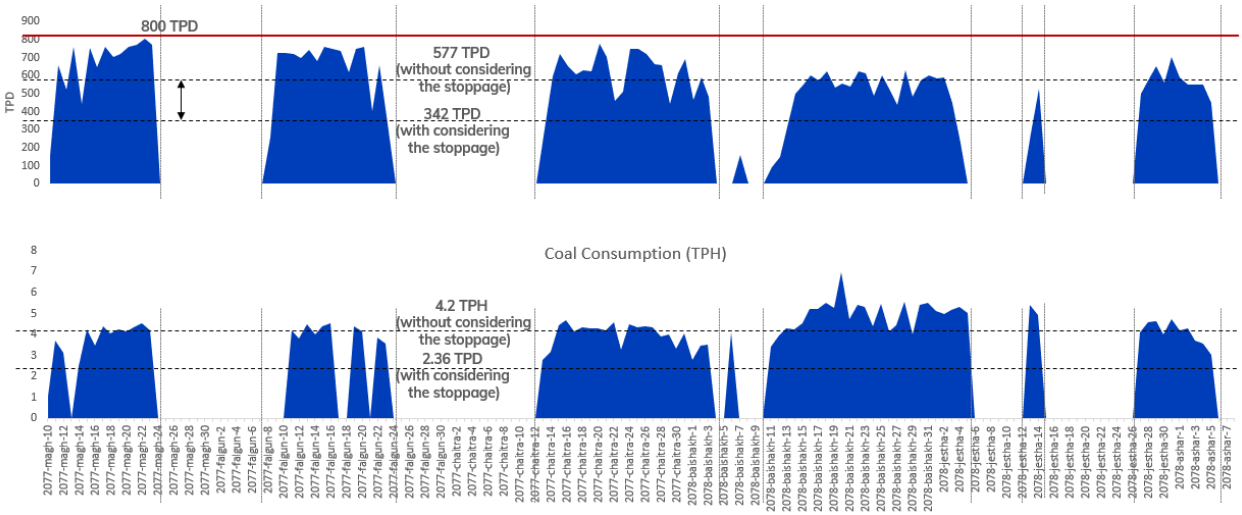
After the several rounds of discussion between acem and the UCIL team, the first joint project between them set out for following objectives:

- Identifying the current problems in every portion of the factory from raw mill to clinker transport.
- Inspection and analysis of energy flow in the factory.
- Suggesting the necessary course of action for reaching the target capacity of 1100 TPD production.

Description of the project

General Plant Running Analysis

The production and coal consumption graph of UCIL for the last 5 months is shown in the figure below. It clearly shows that the average production without considering the stoppage is ~577 TPD whereas with stoppage it is rather 342 TPD which is a large deviation. This means that the first problem that the UCIL needs to focus on is increasing the run time of the plant not in the capacity enhancement. Secondly, as per the plant stoppage analysis, the major reason was found to be Kiln brick lining which accounts for 36.37%. Thus, to tackle this problem, RIU proposes Reinforced Suspension Preheater (RSP) for UCIL.

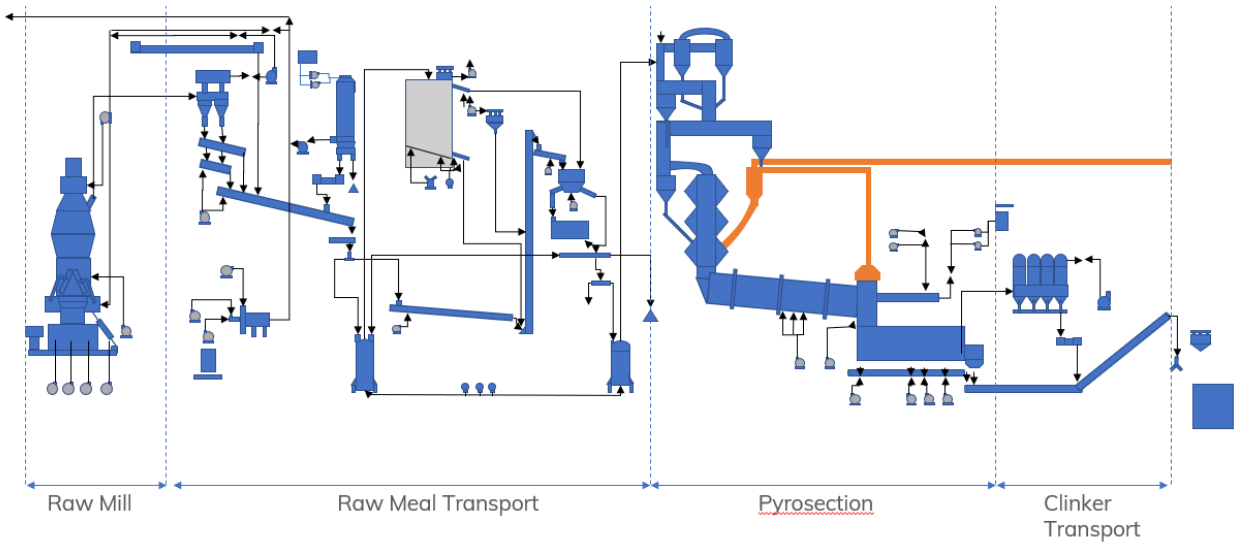


Source: RIU Analysis

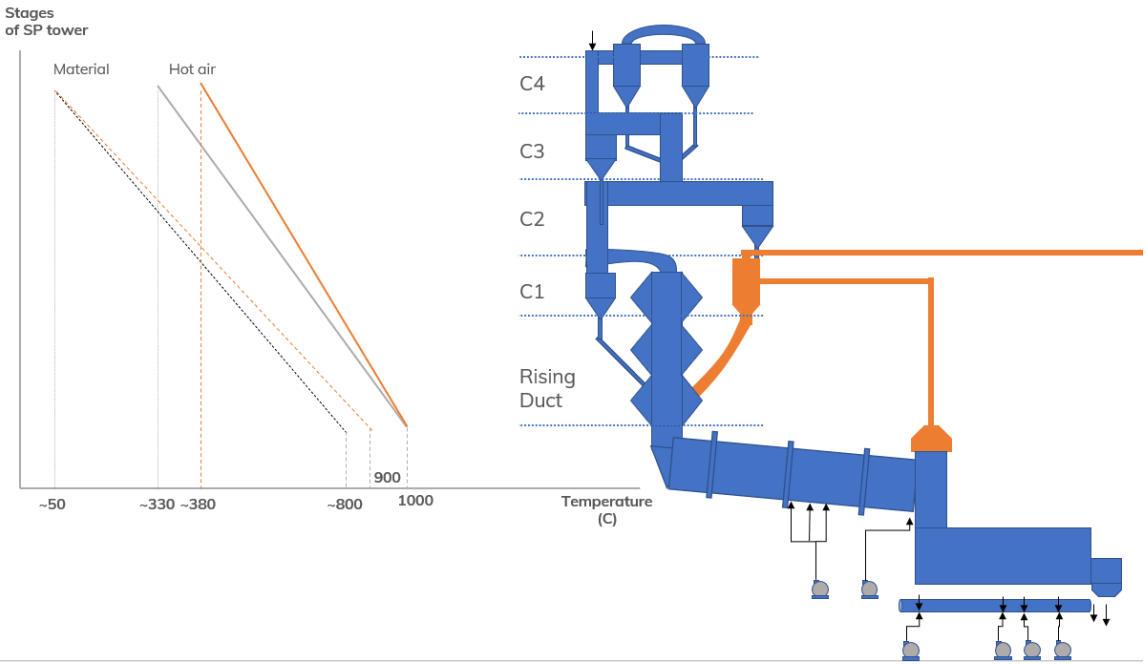
Proposed RSP

Currently due to low degree of calcination in tower, RIU proposes a well proven technology Reinforced Suspension Preheater to solve this problem. A Tertiary Air Duct is taken from the kiln hood to a pre-calciner in the tower. The fuel burning is then split in to 60%(tower):40%(Kiln). This reduces the thermal load in the kiln whereas increases the degree of calcination in the tower. With the installation of RSP, there is not significant increase in the temperature of the tower.

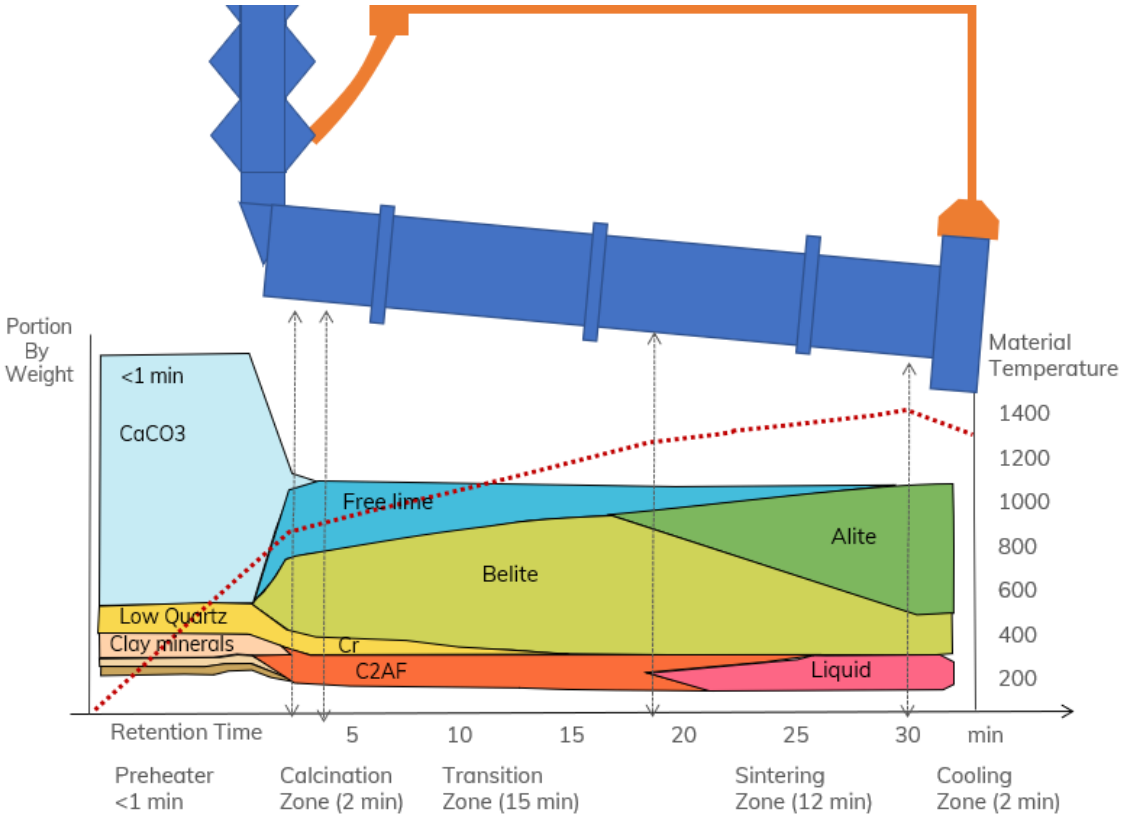
The figure below shows the Time-Temperature-Transformation of the cement in the kiln. Currently the designed SP tower in the UCIL should technically result in 36-40% calcination in the tower however due to improper heat exchange in the tower and improper blending, it is significantly lower. Thus, the proposed RSP results in 90% calcination in the tower and barely 10% remaining calcination in the kiln..



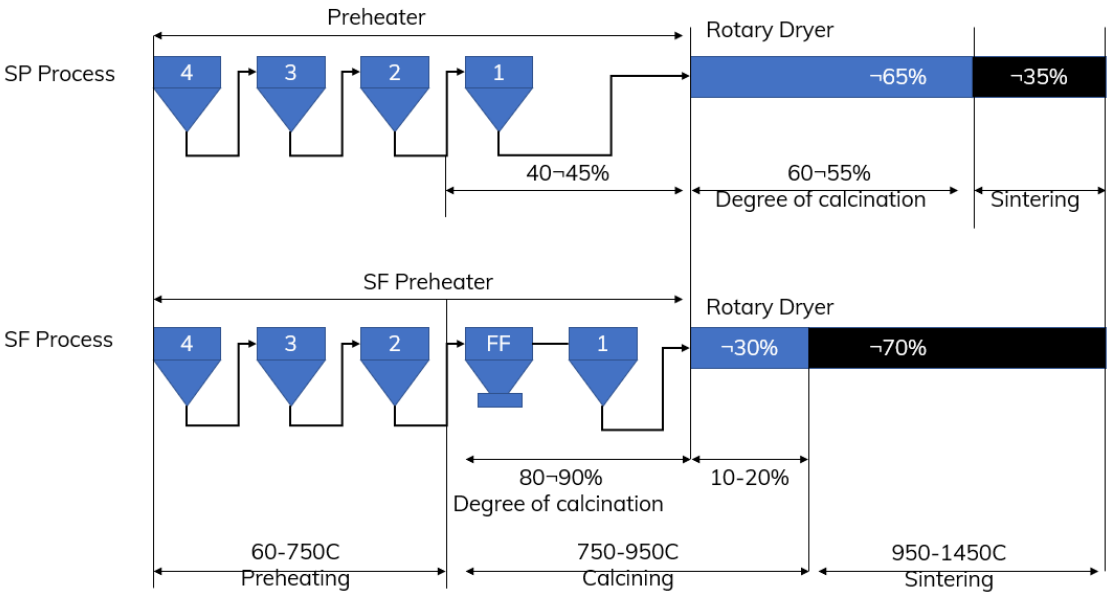
Source: RIU Analysis



Source: RIU Analysis



Source: RIU Analysis



Source: RIU Analysis

Research & Innovation Unit

> *"The Cement Manufacturers Association of Nepal (CMAN) recorded average capacity utilisation across the local cement sector below 30% following the start of a national coronavirus lockdown that started in late April 2021.*

The kiln with the dimensions of 1.8 meter in diameter and 60 meter in length is installed in UCIL maintaining the slope of 3.5% with the horizontal. The rotational speed is 1.8-0.18 RPM. The recent data of UCIL shows that the major reason for stoppage of the plant due to kiln brick lining is 36.37%.

The U.S. bureau for mines formula for passage of particles through rotary cylindrical kiln is:

$t = (1.77 * l * \sqrt{\theta}) / (p * d * n) * F$

Where, t = residence time of material, minutes

l = length of dryer, m

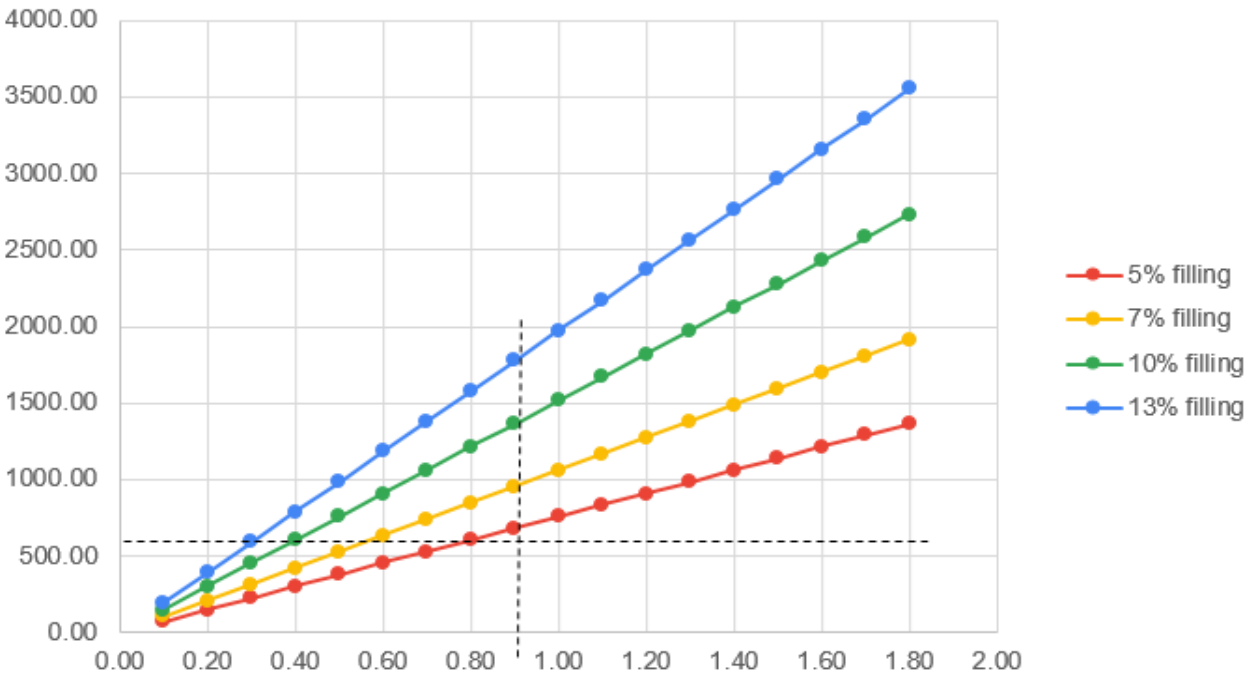
p = slope of kiln, degree

d = diameter of kiln, m

n = revolutions per minute

θ= angle of repose, degrees, of material in dry condition; the angle of repose for limestone and argillaceous materials is approximately 36 degrees.

F = factor is for constrictions in the cylinder; flights and lifters decrease the passage through the cylinder by half thus F=2 for kiln with lifters and flights and F=1 for straight kiln



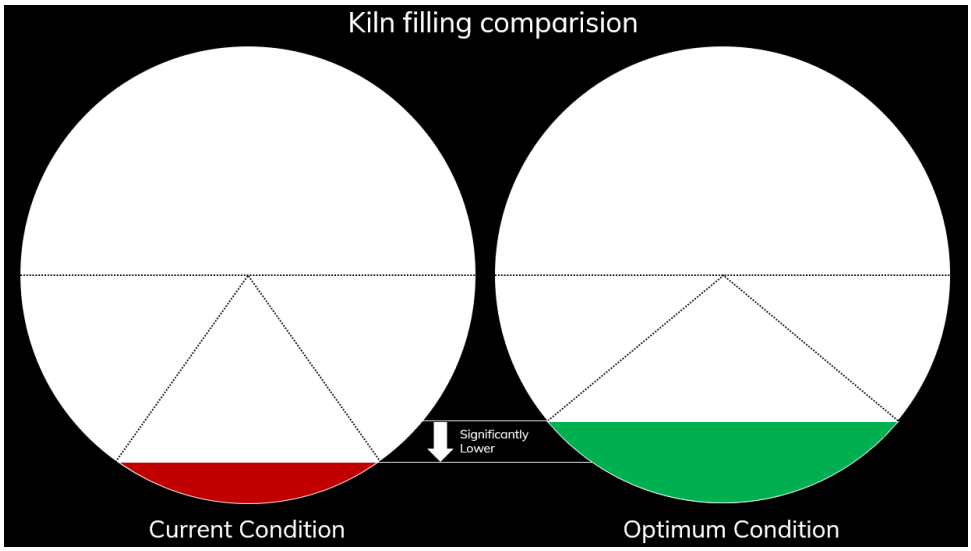
Source: RIU Analysis

The UCIL Kiln has a designed RPM of 1.8 and diameter and length of 3.8, 60 m. The theoretical maximum capacity of the kiln with 13% Kiln filling is ~3500 TPD. Since UCIL team is targeting 1100 TPD, the factory does not need to change the drive system of the kiln to reach the designated throughput.

It is possible to control residence time of the kiln feed by varying RPM, since all other parameters are constant for the kiln installed in UCIL. The kiln can have RPM up to 1.8 and hence the retention time is designed for ~45 minutes. The value of kiln filling percentage controls the clinker production rate. The recent data shows the factory is running with the average of 577 TPD (Considering full run time) of clinker production. This corresponds to kiln filling of 4.1% which is way below the recommended level. This means that the kiln is running almost empty.

It was also found that in the original design of the kiln the theoretical zero pressure point was kiln hood but in practice, the kiln hood should be maintained at slightly negative pressure. However due to lack of reliable sensors in UCIL, the operators are unable to maintain it. As the thermal load is excessively high in the SP tower, it is estimated that the theoretical zero pressure has shifted toward kiln which eventually shifts the burning zone of the kiln. The effect can be seen in the kiln shell as well. This shift can also be validated with higher thermal load in the SP tower.

Currently, ~4.7 tons of coal are burned in the kiln with only 4.1% filling in the kiln. Most of the heat from coal should be given to feed however in current operating condition, the feed is extremely low. Thus, most of the heat is used to heat the brick and shell rather than the material inside. This is the major reason for abnormally high thermal load in the kiln and frequent brick falling.



Source: RIU Analysis

Research & Innovation Unit

> *"Automating sampling and analysis with QCX/Auto Sampling and QCX/RoboLab, and combining with advanced quality control systems, such as QCX/Blend Expert, can have an outsized impact on plant operations, helping to ensure quality and reduce costs, as well as setting a foundation for more sustainable production.*
>
> *-FL smidth*

Collaboration Outcomes

The first project with the collaboration between UCIL and acem included Students, Researchers, and Faculty from acem, and the team UCIL consisted of engineers, workers, in-charges, or department heads according to the involved units. Each member of the collaborations had separate benefits.

UCIL Perspective

Authorities of the industry got the chance to know the problem in the industry from the third party perspective. UCIL is creating Nepali cement experts by giving them opportunities in real industry problems. Nepal-based institutes are affordable in comparison to companies beyond borders.

Student Perspective

Students got the unique experiences to see the theories being implemented in the factory. They got to work with industry experts while solving their problems. Students are more aware of the contemporary situations in terms of technology, finance, and other different aspects of the cement industry.

Researcher Perspective

Researchers got an opportunity to solve local problems. They exposed/trained fellow students in real industry problems which adds value in addition to their curriculum knowledge. It gives a head start to the students after their graduation.

Faculty Perspective

They facilitated the gap between industry problems and student's approaches. They implemented theoretical learning in the industry that they teach in academia. With hands-on industry knowledge, faculties can teach students more on real-life problem solving rather than theoretical approach.

References

[1] Shrestha, Ashish & Ghimire, Anil & Singh, Ajay & Koirala, Dinesh & Khanal, Kshitiz & Maskey, Ramesh. (2017). Energy Use in Nepalese Cement Industries: Case of Udayapur Cement Industries Limited. International Journal of Scientific and Engineering Research. 7.
[2] Department of Industry. Retrieved from https://www.doind.gov.np/
[3] Udayapur Cement Industries Limited. [Online]. "Available: http://www.ucil.org.np/AboutUs. [Accessed: 14-Nov 2021]