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Learning Through Industry-University Collaboration: Observation of Product Innovation Cases Targeting Low-Income Communities

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Abstract: Poverty is one of the most significant problems faced by humanity. Today, a significant number of the world's population, known as the bottom or base of the (economic) pyramid (BoP), lives on less than \$1.90 daily income. Various stakeholders take part in a range of efforts aiming to solve this multi-faceted and complex problem. Among these efforts, innovative product development has gained acceleration in the last two decades with the contribution of private sector actors. Yet, the challenges in practice force these actors to embrace the problem area creatively. At this point, university collaborations offer creative and inspiring ways of approaching the world's complex problems, including BoP initiatives. Nevertheless, despite the rising expectations from collaborative practices, only a minority of ideas are achievable. This study examines four collaboration cases targeting BoP communities, which took place between a global household appliances company and two academic institutions in Turkey. The examination is grounded in participant observation of the collaborations and the researcher's field notes in four diaries. The study sheds light onto the industrial partner's objectives and expectations from the collaboration. It presents barriers in the realization of student ideas and proposes enablers to overcome these barriers.

Keywords: *design for the bottom/base of the pyramid (BoP); innovation; new product development; participant-observation; industry-university collaboration*

1 Introduction

The world has been facing complex problems. Being one of these problems, the level of development remains unequal around the globe. Despite the efforts to improve quality of life and wellbeing of low-income communities, at least 736 million of the world's 7.7 billion population live under \$1.90 a day (Worldbank, 2018, p.1). These communities are described as the bottom (or base) of the (economic) pyramid (BoP) (Prahalad, 2005). They experience problems regarding their basic needs, such as accessing clean water and constant electricity (United Nations, 2018).

A wide range of actors plays a role in the solution of the problems faced by low-income communities. Among these efforts, innovative product development has gained acceleration in the last two decades with the call for private actors to contribute to the problem domain (Hammond & Prahalad, 2009; Prahalad, 2005). Companies, start-ups, and social innovators aim to address social problems with product innovations, however, the challenges in practice force these actors to approach the problem area in a creative way.

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Academic student projects are seen as a source of creativity and inspiration in the solution of the world's complex problems, and as part of efforts aimed for people living at the BoP. These projects may usually address problems related to people's access to clean water, food, energy, healthcare, and education (Kandachar et al., 2009a; Kandachar et al., 2009b; Kandachar et al., 2011; Kandachar, 2012; Viswanathan and Sridharan, 2012). They aim to bring business partners and academy together to alleviate poverty and develop the BoP strategy for mostly underserved countries (Kandachar et al., 2009a). Student projects that took place at Delft University of Technology (TUDelft) are some of the examples of academic collaborations which form basis for building academic knowledge about the BoP problem context (Kandachar et al., 2009a).

Although the search for conceptual student projects comprises the majority of scouting practices, only a limited number of projects become alive. This research aims to find answers to:

1. How do industry-university collaborations take place for the BoP initiatives?
2. Why do the realization rates of student projects remain low for the BoP problem context?

2 Methodology

In order to answer the research questions, this research examines the industry-university collaborations of a global household appliances company. It embraces four collaborations that were carried out with two academic partners in Turkey. The collaborations took place as part of the company's ideation efforts for the African market and aimed at mentoring students to develop innovative product concepts that address the basic needs of the BoP communities in Africa.

Table 1. Description of the observed university collaboration projects

Case number	Project description	Project profile	Student count	Number of acquired ideas	Project execution	Stakeholders
Case 1	Developing innovative product concepts for leveraging the quality of Nigerian BoP.	3 rd year students	41 students	Acquisition of 2 ideas	October 2016 - January 2017	Industrial partners: -Project leader -UX researcher -Food and mechanical engineers -African experts Academic partners (ITU): -Academicians -3rd-year industrial design students
Case 2	Developing innovative product concepts for improving practices of Nigerian BoP related to washing laundry.	4 th year students	49 students	Acquisition of 4 ideas	October - November 2016	Industrial partners: -Project leader -UX researcher -Mechanical engineers -African experts Academic partners (METU): -Academicians -4th-year industrial design students
Case 3	Developing an alternative cooking concept for the BoP communities.	Graduation project	1 student	Utility model registration by METU Technology Transfer Office	February - May 2018	Industrial partners: -Department manager -UX researcher -Engineers Academic partners (METU): -Academicians -A 4th-year industrial design student -METU Technology Transfer Office
Case 4	Developing an innovative food drying concept for the BoP communities.	Graduation project	1 student	Utility model registration by METU Technology Transfer Office	February - May 2018	Industrial partners: -Department manager -UX researcher -Engineers Academic partners (METU): -Academicians -A 4th-year industrial design student - METU Technology Transfer Office

The collaborations were initiated with Istanbul Technical University (ITU) between May 2016 - January 2017 (Case 1), and Middle East Technical University (METU) between August - November 2016 (Case 2) and December 2017 - May 2018 (cases 3 and 4) in a timescale including planning, execution and assessment of the collaboration projects. The observed cases involved a 3rd year studio project at ITU (İTÜ Kurumsal İletişim Ofisi, 2017), a 4th year studio project (METU Department of Industrial Design, 2017) and graduation projects at METU (METU Department of Industrial Design, 2018). The details of the collaboration projects are given in Table 1.

The researcher observed the collaborative process by following the complete participant observation methodology. The observation took place between February 8th, 2016 and August 9th, 2018. During the time of the observation, the researcher worked in the company as a UX researcher at the Innovation and Technology Management department in Turkey and supported product development and collaboration activities of Corporate Innovation department in Germany for the projects targeting the BoP communities. Between these dates, the researcher was involved in two product development and four university collaboration projects. The researcher mediated the communication between the academic partners and the stakeholders within the organization: academicians, students, project leader/department manager, the project team, engineers and African experts from several departments. Meanwhile, she carried out complete participant observation of the university collaborations and conducted semi-structured interviews with industrial and academic collaboration partners to formulate their collaboration objectives (Figure 1).

Figure 1. Research Methodology

The researcher noted the facts and insights from these collaborations by keeping a work log and four diaries in English and partly Turkish. Note taking took place before, during and after an event, related to industry-university collaboration projects. Content analysis was applied to the diary contents to find answers to research questions.

The diaries contained information about:

- Date
- Project timescale
- Meeting information
- Stakeholders involved
- The tasks and their subtasks
- Impressions/notes about students' research and ideas
- Students' questions and needs of information
- The product development team's expectations from student projects
- Academicians' expectations from the project
- Challenges faced
- Sketches/frameworks developed during the projects

3 Results

3.1 Collaborations to Support the Product Development Process

Describing the company's product development process is a necessary step in explaining the expectations from the academic collaborations. By being involved in the company's two product development cases, the researcher observed the company's product development approach for the BoP to have five steps: i. strategy development, ii. scouting, iii. ideation, iv. prototyping, and v. production (Figure 2). These phases showed non-linear and iterative characteristics.

Figure 2. The observed product development processes

The company carried out several product development and collaboration projects simultaneously to build the know-how about the problem domain. Industry-university collaborations took place to accompany these projects depending on the project strategy and the needs of the departments. The collaborative projects targeting the BoP communities, primarily informed scouting and ideation phases of diverse product development projects. The following table presents how product development process phases were shaped during the collaborations.

Table 2. Product development and industry- university collaboration phases

Phases	BoP product development processes	Industry-university collaboration
Strategy development	Planning and decision-making about the project and its management.	Taking action to collaborate with an academic partner on the BoP theme, which would inform the product development practices.
Scouting	Scouting information about user accounts to inform market segmentation and value proposition.	Collecting/validating insights about user characteristics (people's needs, problems, ways of living and daily behaviours) through student projects.
Ideation	Generating the pool of product concepts through internal and external collaborations.	Gathering the pool of innovative student ideas and acquiring the ideas that pass the strategic assessment.
Prototyping	Prototyping the product concepts and evaluating them based on their performance and other criteria with strategic importance.	
Production	Preparing the product for mass manufacturing.	

3.2 The Stakeholders and Their Role in the Collaborations

The observation of the collaborative process revealed information about the departments and contributing stakeholders. The stakeholders in the company were identified as the problem owner, mediator and other departments, along with the manager/the project leader, African experts, engineers, and the user-experience researcher (Figure 3).

- The mediator department was in charge of the university collaborations, did planning and mediation of the university collaborations. The department formulated the company's needs by communicating with other departments, turned them into substantial projects and found partners to collaborate internally or externally.
- Problem owner department wanted to carry out university collaboration on a specific theme and contacted the mediator department for this purpose in Case 2. Mediator department was also a problem owner in cases 1, 3 and 4.
- Being affiliated to the mediator department, the manager (project leader in cases 1 and 2) made decisions about the collaboration's initiation, project confidentiality, and themes. They ensured the collaboration was effective, and when needed, they communicated with internal stakeholders for sharing technical knowledge with academic partners.
- Experts and engineers contributed to the collaborations by sharing technical or user-related knowledge. They also took part in the assessment of student ideas.
- The user experience researcher, being a Ph.D. researcher in the same academic domain at METU, mediated communication between the company and the university and supported the user-centred research process of

students with the knowledge of the BoP communities in Africa. Besides, she coached industrial stakeholder for mindset development in human-centred and industrial design approaches.

Meanwhile, three stakeholders were identified in the university setting:

- Academicians were the decision-makers about the project topics, the project profile (e.g., studio year and studio team), period, and students' rights. Additionally, academicians guided students' idea development.
- Students worked on an industrial design problem for academic achievement in an academic time span and context.
- University official body (e.g., METU TTO) examined the confidentiality agreements of the company and managed the application process of intellectual property rights by following the official requirements and regulations.

Figure 3. The stakeholders of the collaboration projects

3.3 The Flow of Operations During Collaborations

The collaborations' operational flow was observed to involve five steps: i. the planning and project initiation, ii. students' user research and need formulation, iii. pre-jury assessments, iv. final jury assessments, and v. prototyping of the acquired ideas (Figure 4).

Figure 4. Company's flow of operations regarding the collaboration phases.

The collaborations were aimed to carry out with academic partners having a long-standing background of industry-university collaborations (Evyapan et al., 2006; Şatır & Leblebici-Başar, 2008; Börekçi & Korkut, 2017). With this intention, the industrial partner contacted two academic partners. Several meetings took place in the planning step in order to set the expectations from the projects appropriately. This step had crucial importance in transparent communication of the project objectives and the resources regarding the duration, labour, confidentiality, intellectual property rights, student mentoring capacity of the industrial partner and sharable technical knowledge. Meanwhile, the industrial partner suggested a number of project themes to the academic partners. The academic partners decided on the project profile considering the academic objectives and characteristics of the project. As the objectives of each studio (e.g., junior, senior studios) differed in terms of gaining students a set of skills, the match between

these skills and the project objectives were emphasized by academic partners. The difficulty of the project theme was another consideration in formulating the project profile.

The collaborations were aimed to start once the project's objectives were communicated, the project profile was decided upon, and confidentiality and intellectual property rights procedures were resolved. The following table shows the stakeholders and their objectives, which needed to be communicated during this step.

Table 3. Objectives of the stakeholders

Stakeholders	Industrial Stakeholder	University	African BoP communities
Objectives of the Industrial Stakeholder	1. Increase revenue through market growth 2. Increase innovation power	1. Build a long-term research and development network with over-achiever universities in Turkey 2. Acquire ideas and expand the idea pool 3. Scout creative ways of thinking and doing	1. Develop products that will address the needs of the BoP communities 2. Increase African people's familiarity with the brand 3. Create and sustain the business with Africa
Objectives of the University	1. Carry out collaborations with a global company 2. Empower students through commercialization of ideas 3. Develop a long-term research agenda with the industrial partner, and publish academic research	1. Gain students the designer skills by carrying out a studio project about a valid design topic 2. Increase the number of patents and utility models 3. Enable students to participate in the design competitions	Contribute to the solution of the global and social problems
Needs of the African BoP communities	Buy affordable and durable products that perform well in the context of Africa	-	Increase their families' life quality

Despite being involved in a wide range of industry-university collaborations in the domains of engineering, the members of the mediator department had carried out neither industrial design collaborations nor collaborations for low-income communities, before. Having a background in industrial engineering and specialization in industrial design, the UX researcher was asked to mediate the communication between the industrial and academic partners on the grounds of t-shaped expertise (Brown, 2005). The UX researcher aimed to ensure common grounds for communication by taking part in project formulation, writing design briefs, and sensitizing the industrial and academic stakeholders for each other's' expectations (Figure 5).

During the planning of the collaborations, the academic partners raised their concerns regarding the lack of direct contact with the user group, which might impact students' research and empathy processes. To this, the industrial partner informed students about the problem domain. In cases 1 and 2, the UX researcher and the project leader made a presentation about Africa and shared their holistic understanding obtained through field observation, expert opinions, and research (Table 4; Figure 6). Following this, African employees carried out half-a-day workshops to mentor students about human-centred approaches and product concepts' perceived usability. For cases 3 and 4, the UX researcher mentored students to build empathy with African people throughout the semester by weekly meetings. Moreover, the students were invited to the industrial partner's office for sharing non-confidential knowledge.

Table 4. The components of the holistic knowledge shared by the industrial partner

Research Type	Information Type
Field Observation	The insights of employees who have visited Africa
Expert Opinions	The insights by African employees
Market Research	Key non-confidential insights from the market research
Academic Research	Scientific knowledge about people, needs and behaviours
Secondary Research	The information obtained from secondary resources such as google search, blogs, and video channels

In all cases, students were mentored for their ideas' technical feasibility by the department manager and the engineers from various departments. The mentoring began in parallel to the preliminary design research and problem identification and continued as the product concepts emerged and were revised. The number of engineers from contributing departments varied depending on the project theme and the necessities of the collaboration. For instance, Case 1, having a broader theme of increasing quality of life of the BoP communities, resulted in a wide range of design suggestions that needed to be mentored and evaluated by engineers from various backgrounds and departments. Conversely, during Case 2, technical feasibility was evaluated mainly by mechanical engineers.

Figure 5. Mediation of the collaborations

During assessments, academic studies pointing at the product development considerations for the BoP context were reviewed (Van Boeijen et al., 2013, p. 37; Castillo et al., 2014; Whitehead et al., 2014) (Figure 6, the rightmost picture). However, the considerations were not appropriately utilized due to the industrial partner's prioritization differences. The emphasis was on the technical feasibility, and the overall assessment approach was grounded on expert opinions primarily for the concepts':

- technical feasibility,
- patentability,
- innovativeness,
- manufacturability,
- durability,
- efficiency,
- perceived human-centeredness and usability,
- context fit,
- aesthetical appeal and novelty,
- projected manufacturing costs, and
- projected product price.

A group of employees including the department manager/the project leader, the UX researcher, engineers from other departments and African experts (only in cases 1 and 2) assessed student ideas for acquisition potential. In Case 2, the final jury took place with the participation of an international group of employees, whereas in the other cases, department manager/project leader and the UX researcher participated in the juries, and the assessment by engineers continued from preliminary to final juries. The project's confidentiality was a significant concern during cases 3 and 4; the decision of the acquisition had to be given before the final jury since the projects became public.

The final step was the decision of acquisition. In cases 1 and 2, the product concepts, which passed the strategic assessment of the company, were acquired by the industrial partner with the purpose of incorporating them into the company's product development agenda for Africa. After the acquisition, the products were prototyped and assessed for effectiveness. All product concepts needed either technical improvements or further research and development before preparing them for mass manufacturing.

Figure 6. Company presentations, critique sessions of African experts, and the UX assessments of conceptual products (From left to right)

3.4 The Objectives of the Industrial Stakeholder

Three objectives were identified during the observation of the collaboration practices. They are elaborated in the following sections.

3.4.1 The Long-Term Relationship with Universities for Building a Learning Network

Forming a network is a vital action in embracing complex problems. In the observed state, the primary goal was to build a *learning network* that would shape the company's long-term value chain.

The network involves three nodes, each of them being the stakeholders of the industry-university collaboration: i. the company, ii. university and iii. African BoP communities (Figure 7). The objectives of each stakeholder determine the expectations from the collaboration. The sustainability of the network is achieved through the fulfilment of these objectives. The learning for designing for the BoP strengthens the network sustainability.

Figure 7. Industry-university collaboration forms the network

This long-term network was an opportunity to become familiar with the curriculum so that the expectations from future employees would be appropriately set, and employees' skill sets could be defined accurately. In addition to this, the organization gained knowledge about academic institutions' fields of expertise, the academics working in the domains carrying strategical importance for the company, and identified potential employees among bachelor's, master's and doctorate students. For instance, a 3rd year design student, whose idea was acquired by the company during Case 1, was later on employed by the company as a project student.

3.4.2 Industry-University Collaboration as a Source of Creativity and Ideation

The organization approached the student projects as a source of creativity and ideation for innovation. The researcher observed that the industrial partner associated creativity with out-of-the-box thinking and designerly skills. These keywords were frequently mentioned by the department manager during cases 3 and 4. On a closer examination, these qualities happened to be in relation with students' human-centred thinking, the concepts' aesthetical appeal, and forms' simplicity.

The industrial partner prioritized students' out-of-the-box-thinking concerning the way users' needs, behaviours, and real context were translated holistically into the product design. In addition to human-centeredness, the industrial partner paid attention to students' unique approaches to products' working principles. The students were mentored

to avoid a technology-driven mindset and to adopt a back-to-basics approach due to resource-constraints of Africa. This resulted in students' exploration of the alternative energy generation principles and incorporating them into their designs. This was the most evident in Case 2.

Moreover, designerly skills were characterized by the visual simplicity and the appeal of form, colour, and/or material. For example, in Case 3, the student embedded traditional patterns into his design, which was appreciated by the mentors (Figure 8).

Figure 8. Traditional patterns applied onto the product part's surface, adopted from METU Department of Industrial Design (2017, p. Horus)

3.4.3 Industry-University Collaboration as a Source of Inspiration and Scouting

The organization prioritized not only product development skills but also students' ways of approaching the problem area. Students' skills to deal with problem complexity were paid attention to, given that students were unfamiliar with designing low-cost and off-grid products for distant cultures and the BoP context had resource-constraints. Case 1 provided diversity in terms of inspiration. Respectively, students' secondary research skills were paid attention to since the understanding about African culture was determined by it and the insights from this stage informed problem identification and conceptual designs.

During the preliminary jury of Case 1, a student presented an organic material-based water filtering technology as the foundation of her product concept. She mentioned that she had reached this filtering method through an academic literature review. Although the product concept raised concerns about usability, the way the student approached the problem context was appreciated.

3.5 The Barriers in the Realization of Student Projects

Realization potential of student ideas is comparatively low once the number of product concepts are taken into consideration. The researcher observes three aspects that cause barriers to the realization of ideas.

3.5.1 Cultural Differences

The access to information about the BoP communities was a challenge given that students' only tool for data collection was secondary research and not observation. Furthermore, the quality and accuracy of the information gained from secondary research were questionable. To overcome this, the industrial partner supported students with non-confidential information obtained through various research channels (See Table 4). Nevertheless, students' cultural differences were observed to influence their approach to concept development. This caused a barrier in products' fit into the BoP context, such as replacing the practice of carrying on the head with backpacks in several student projects.

3.5.2 Confidentiality Concerns and Intellectual Property Rights (IPR)

Knowing that the objectives of the industrial partner were to develop affordable products for Africa, the industry-university collaborations were carried out to inform the scouting and ideation practices of the company. Student projects which would pass the company's strategic evaluations in the long-run were to be mass-manufactured. Therefore, student projects' patentability gained increasing importance through the course of collaborations. The expectation of patentability resulted in keeping project topics and progress confidential until the industrial partner communicated their decision about which student projects would be acquired. Meanwhile, the industrial partner researched the conceptual products' patentability and innovativeness, however, collaboration durations were a barrier in achieving a complete review.

3.5.3 The Difficulty of the Assessment

Student projects were assessed by the industrial partner's stakeholders, mainly engineers, regarding projects' acquisition potential. The UX researcher sensitized the assessors with industrial design approaches, student presentations, and different levels of detail and concept quality across the cases. Nevertheless, the challenges that emerged during the experts' assessments were observed as:

- Projects being grounded on the principles in which feasibility assessment may require long-term research and development projects (Case 1).
- Concepts not necessarily being human-centred, however, having usability as the main concern with improved parts or additions, which contradicts with the low-cost strategy of the company (cases 1 and 2).
- Limited diversity among student projects due to constraints in the off-grid working principle (Case 2).
- The difficulty of product value assessment for patentable and non-patentable qualities (cases 3 and 4).

3.6 The Enablers of the Realization of Student Projects

Based on the insights gained from the observation of the processes, the following directions are suggested to improve the industry-university collaboration practices for the BoP.

3.6.1 Appropriate and Timely Feedback

During observation of the cases, *feedback* was identified as an enabler of the learning process regarding better communication between collaboration partners and effective project outcomes. Appropriate, timely feedbacks can contribute significantly to the learning process of students. In this, feedbacks provided by the mentors (department manager/project leader, UX researcher), engineers, and experts play an important role.

The feedback between the project team and academicians is also as valuable as the former on the grounds of ensuring the objectives. By this means, the industrial partner learned about collaborating with industrial design departments. On the other end, the academic partners learned about the objectives of the company and embraced a complex design problem.

3.6.2 Creative Sessions Facilitated by the Problem Owners

Collaborative design practices provide opportunities to overcome cultural differences and align the expectations of stakeholders. For example, the involvement of the African experts in students' critique sessions during cases 1 and 2, was observed to create a positive impact about building empathy with African context. Besides, it gave a chance to convey the message about the industrial partner's objectives more effectively. Therefore, facilitation of creative sessions by the problem owners is believed to empower students' skills related to the understanding of the African people.

Additionally, by creative sessions, students can be empowered for their out-of-the-box thinking skills. The researcher observed that most of the students' user research was followed by the review of do-it-yourself solutions and start-up products targeting Africa. This was limiting students' ways of thinking into a narrower solution space. On the other hand, in order to empower creativity, problem-solving skills can be facilitated before conceptual product development. For this purpose, students can be introduced functional problems and parameters which they could creatively embrace. The back-to-basics thinking can be encouraged through stimulation of creativity, especially regarding the working principles. To make it happen, creative problem-solving techniques can be reviewed, and toolkits for functional analysis can be designed.

3.6.3 Business Mindset

Business development is an integral part of product development. Moreover, the complexity of the BoP problem context makes it crucial to embrace product concept and business model development simultaneously based on human-centred insights. The business mindset was observed to be the missing element of industry-university collaborations for the BoP. Knowing that designers are increasingly taking part in business development with their designerly ways of thinking, further collaborations can be formulated to include business development perspectives.

3.6.4 Interdisciplinary Project and Team Formulation

Interdisciplinary team formulations may ease reaching the objectives on the grounds of increasing creativity and inspiration potential and making the project assessment convenient for the industrial partner's stakeholders. Formulating industry-university collaborations as projects, to which students from different backgrounds contribute, may benefit collaborations regarding facilitation of multiple points of view. With the participation of students from the fields of industrial design, mechanical engineering, and business management, the project outcomes would be

more applicable. Moreover, giving place to students from fundamental sciences (e.g., physics) and materials engineering, the project outcomes would yield out-of-the-box perspectives and working principles. Availability of social sciences students (e.g., sociology) would provide opportunities to gain awareness about cultural differences and give meaning to distant geographies' cultural patterns. Therefore, rather than seeing design as a complementary creative process of engineering, approaching it as a team effort would yield impactful results.

4 Conclusion

Designing *for the* BoP constitutes the majority of product development practices due to challenges in designing *with the* BoP communities. Among those practices, university collaborations require a significant amount of effort. The collaborations give novice designers (students) an opportunity to contribute to one of the world's most complex problems with their designerly ways of thinking. On the other hand, the realization of student projects remains a challenge.

This research provided insights on four industry-university collaborations in the context of product development for the BoP communities. Through the examination of the diaries regarding the notes taken during the long-term complete participant observation of the industrial partner's product development and collaboration process, and by applying content analysis to them, this research presented the objectives, barriers, and enablers of the collaboration projects. The observed cases represented the first industrial design collaborations of the industrial partner's mediator department and its project team. They took place as part of the BoP learning process to inform the industrial partner's scouting and ideation process.

The collaborations formed a learning network between the industrial partner, academic partners, and African people. Meanwhile, the flow of operations became touch-points of collaboration stakeholders, which would impact the sustainability of the network once the objectives were communicated clearly during these touch-points. Through these, the industrial partner learned about how to set the expectations from industry-university collaborations with industrial design departments and gained familiarity with differently formulated design practices, such as studio project and graduation project, project scope and theme, and industrial design approaches and visual presentations. Collaborations provided a channel of creativity, which contributed to the ideation practices of the industrial partner. Besides, the collaborations gave an opportunity to inspire the way the industrial partner's stakeholders approach the BoP context. Whereas, academic partners gained familiarity with the practices of the industrial partner and students gained skills by embracing a complex design problem.

Observation of the collaborations revealed that the barriers in making this happen were the cultural differences, which impacted students' concept development. Besides, the emphasis on finding innovative working principles influenced the assessment processes due to research and development requirements. Additionally, low-cost and off-grid product concept development was a challenge due to its limiting effects on the solution space. Moreover, the assessment of a project's value was recognized to be a difficult aspect. Finally, confidentiality, due to student projects' patentability through the collaborations was also revealed as a challenging issue.

The barriers could be overcome by formulating the student projects diversely and providing students with timely and appropriate feedback. In this, facilitation of creative sessions where the focus is more on problem-solving rather than product development, inter-disciplinary mindsets which extend the solution space, and concept development together with a business mindset, are necessary.

5 Limitations and Further Research

The study aims to fill the gap in the body of knowledge regarding the industry-university collaborations for the BoP context. Although this research is limited to the observation of the collaborative practices of one company due to operational complexity of observing multiple companies at once, it forms a valuable source to discuss the dimensions of collaborative practices for the BoP problem context. Nevertheless, the duration of the observation and the number of cases observed based on their differences in practice, enrich the outcomes of the research. Further research could be carried out with multiple companies working on product development for the BoP.

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