WHY UNIVERSITIES WANT TO JOIN CDIO?

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ABSTRACT

The CDIO initiative started in 2000 with four universities, in 2011 there were already 62 schools and today there is more than 120 universities. The growing number of universities in CDIO shows that the initiative provides something that the engineering programs, schools, faculties and universities are looking for. The CDIO initiative can be seen as an innovation aiming at improving engineering education. An innovation is an idea, practice, or object that is perceived as new by an individual or other unit of adoption. The characteristics of an innovation, as perceived by the members of a social system, determine its rate of adoption: relative advantage, compatibility, complexity, trialability and observability. Universities planning to join CDIO initiative are thus operating with an innovation having these general characteristics. But what are universities thinking when they are applying to join CDIO initiative? Why do universities want to join CDIO? One way of answering these questions is to look deeper in their application documents that universities produce during the application process. The applicant universities answer in the CDIO questionnaire a set of questions such as “Why does your university want to join the CDIO Initiative?” and “How do you expect CDIO to impact these programs?”. To understand how the applicant universities perceive CDIO initiative as an innovation 55 CDIO applications from 2010 to 2016 were analyzed using content analysis. Based on the analysis we can conclude that universities see CDIO approach very positively. The approach is expected to have remarkable impact on engineering education, the CDIO approach connects well with earlier development activities in the universities, it provides tools for development and it is a network for learning and sharing experiences.

KEYWORDS

Join CDIO, CDIO application, Innovation characteristics, Standards: 1-12

INTRODUCTION

The CDIO initiative started in 2000 with four universities, in 2011 there was already 62 schools and today there is more than 120 universities. The growing number of universities in CDIO shows that the initiative provides something that the engineering programs, schools, faculties and universities are looking for. At the moment, the procedure to apply for a membership in CDIO initiative is quite simple. The first part of the procedure is as the Knowledge stage in the Innovation-Decision process (Rogers, 2003): the university should learn what CDIO is and how the CDIO approach functions. The details of the procedure are described in the CDIO website (http://cdio.org/participate/join-cdio). The CDIO application provides information on the applying university and their plans in education development. For example, the applicant

provides information about on their motives for joining the CDIO Initiative, which programs they plan to apply CDIO, what are their future plans for education and what is their experience in education development.

Rogers (1995) defines an innovation as an idea, practice, or object that is perceived as new by an individual or other unit of adoption. The universities planning to join the CDIO initiative are thus operating with an innovation: The CDIO initiative (CDIO, 2016) can be seen as an innovation aiming at improving engineering education. To be more precise, we should actually speak about an organizational innovation. It refers to the creation or adoption of an idea or behavior new to the organization (Daft, 1978; Damanpour, 1996). The CDIO approach is not only an innovation rather it is an organizational innovation which is perceived new by a program, school, faculty or university.

The characteristics of an innovation, as perceived by the members of a social system, are one important explanation of the rate of adoption of an innovation. The generalized characteristics of an innovation produced by several studies are relative advantage, compatibility, complexity, trialability, and observability. Other factors affecting an innovation's rate of adoption are 1) the type of innovation-decision, 2) the nature of communication channels diffusing the innovation, 3) the nature of the social system in which the innovation is diffusing and 4) the extent of change agents promotion efforts in diffusing the innovation. Still, most of the adoption rate of an innovation is explained by five characteristics. The general characteristics of an innovation are described in the table below. Basically, an innovation is more adaptive when these characteristics are present. Only exception is the Complexity, which is negatively related to the adoption – less complexity and more simplicity is key to the adoption of an innovation. (Rogers, 1995, 2003)

Table 1. Innovation characteristics (Rogers, 2003).

Characteristic	Description
Relative advantage	Relative advantage is the degree to which an innovation is perceived as better than the idea it supersedes.
Compatibility	Compatibility is the degree to which an innovation is perceived as being consistent with the existing values, past experiences, and needs of potential adopters.
Complexity	Complexity is the degree to which an innovation is perceived as difficult to understand and use. Any idea may be classified on the complexity-simplicity continuum.
Trialability	Trialability is the degree to which an innovation may be experimented with on a limited basis.
Observability	Observability is the degree to which the results of an innovation are visible to others.

In this research, these characteristics were searched from the applications of the potential CDIO universities. The research aimed to recognize which elements of the CDIO approach are the ones that attract new universities – which characteristics of the innovation are important to the applicants.

In the next section, the research approach is explained. The results are reflected using the innovation characteristics after the research approach. Finally, the paper discusses and concludes the key findings.

RESEARCH APPROACH

The research question this paper has is “What is the motivation of universities to join CDIO?”. The research question is answered through the presented innovation characteristics – what are key characteristics that attract universities to join CDIO initiative.

The data for this paper comes from the CDIO applications that universities have done. The CDIO application normally contains three different elements: the application, self-evaluation and supporting letters. This study focused on the actual application, which gives answers to the predefined set of questions. The universities joining CDIO know that their applications will be widely reviewed by other CDIO member universities. During the application process the applicant university is all the time identified – it is not a blind review. In this research the university connection is removed and only the texts provided in the applications are used.

Altogether 55 CDIO applications from 2010 to 2016 were analyzed. The analyzed applications are such that the author had some connections either through the role of acting as a regional leader in the European region or applications that the author has been reviewing otherwise. The research data is from the “Why does your university want to join the CDIO Initiative?” question of the CDIO application questionnaire.

The answers of the 55 applications were collected in a MS Access database. Content analysis was used to analyze the answers of the applications. Content analysis is a research technique for systematically analysing written communication such as in this paper the CDIO application represents (Weber, 1990). It allows the researcher to analyze relatively unstructured data in view of the meanings, symbolic qualities, and expressive content (Krippendorff, 2012). In content analysis, all answers are processed and interesting and relevant information is collected. The collected information was categorized using the five innovation characteristics presented earlier. The presented results follow the original characteristics and their definitions except using term Simplicity instead of Complexity, because the collected information refer to innovation Simplicity rather than Complexity.

The research approach had some limitations. First, the applications analysed were not randomly selected rather it was a fixed set of applications available. Second, some of the provided quotes of the applications might be difficult to understand why they are placed under some category. The quotes are taken from a longer text context and this might make them to look somehow problematic. Third, this study focused only on the first question of the CDIO applications although the applications might have provided relevant information elsewhere in the applications too.

RESULTS

The analyzed applications came from 22 different countries mostly from the CDIO European region. Most applications came from Russia, Finland and Sweden.

The universities applying to CDIO provided several reasons for their interest in joining CDIO initiative. The reasons were classified according to the five characteristics of an innovation presented earlier in table 1. All five characteristics were identified in the applications as can be seen at the table 2 showing the frequency of the reasons. Altogether 169 reasons to join CDIO

were provided. On average each university had three reasons for their willingness to join CDIO. Three categories covered almost 80 % of the reasons.

Table 2. Frequency of the reason to join CDIO.

Characteristic	Frequency	Percentage
Relative advantage	43	25 %
Compatibility	41	24 %
Simplicity	14	8 %
Trialability	25	15 %
Observability	46	27 %

Reasons to join CDIO: Relative advantage

Category "Relative advantage" was the second most common category of reasons found in the applications. The reasons emphasized the suitability and superiority of CDIO initiative for engineering education. The applications had reasons such as:

- *The CDIO framework is a good model for engineering education that stresses product lifecycle*
- *CDIO is a valuable standard for our engineering education*
- *The university has identified the CDIO initiative to be the leading force and international cornerstone in the innovation of engineering education*
- *The CDIO approach is probably the most direct and wise one.*

Many applications underlined the impact that CDIO can make to their programs. Others stressed the overall impact on their development such as

- *That can guide us in our long-term and comprehensive development work for all our engineering programmes*
- *An urgent need for a new model for engineering education*
- *This is what we are searching for to help us better educate our students*
- *The joining with CDIO Initiative gives us a chance to fast and efficient rearrangement the whole education system*
- *We, as a faculty, are convinced that CDIO will help us fulfil our educational mission.*

Others emphasized the impact on the quality of their education:

- *The main reason for coming is the need to improve the quality of engineering education by reform of educational programs*
- *With the aid of CDIO initiative we can guide and support our development work towards higher quality education that is relevant to the working life*
- *The need to improve the quality of engineering education by reforming educational programs.*

Universities mentioned the impact on the working life relevant too:

- *The students trained with the CDIO skills will be even more attractive to regional and national companies and businesses*
- *The CDIO standards and framework can help us be more systematic in reviewing our programs, for further improving the education with the goal of graduating better engineers for industry.*

Reasons to join CDIO: Compatibility

The reasons to join CDIO in the category "Compatibility" polarized in two main reasons: Fit to the university/program vision and similarity of the university/program development activities with the CDIO approach. The statements stressing the fit to the university/program vision included following expressions for example:

- *Fit well with the School of Engineering's Goals and Values*
- *One that fits our vision.*
- *We realize that our philosophy is very much in line with that of CDIO*
- *The CDIO initiative seems to correspond well to that vision.*
- *The CDIO framework resonates with several distinctive features of our university.*
- *CDIO Initiative alignment corresponds with the fundamental orientation of the university to combine academic education, scientific research and practical usage of deep knowledge.*
- *We find that the CDIO's initiative is consistent with the university vision*
- *The CDIO concept at the one side fits perfectly well into our engineering profiles and philosophy.*

The similarity of the CDIO approach and the development activities of the university/program were underlined strongly as well:

- *The CDIO process of project based curriculum development and ongoing review is consistent with the ideals*
- *We believe our philosophy in teaching design and manufacture aligns very well with the CDIO approach.*
- *Our design teaching approach follows some of CDIO principals to stress engineering fundamentals set in the context of conceiving, designing, implementing and operating of real-world systems and products.*
- *The development process and the bachelor curriculum turn out to be very much in line with the CDIO approach and meet many of the CDIO Standards*
- *For more than twenty years we have continually developed our engineering programmes placing much focus on a close relationship with industrial partners, particularly regarding students working in integrated projects.*
- *University already may be quite close to the CDIO concept in some aspects.*
- *University of Technology has taken large steps to develop the education provided, based on theories of learning and on implementing a pedagogic idea inspired by the CDIO standards.*
- *The CDIO philosophy has a good fit with the activities of the department*
- *Joining CDIO will thus contribute to the university's on-going efforts.*

Reasons to join CDIO: Simplicity

In the original model, term Complexity was used, but since the applications clearly emphasized the simplicity not the complexity as a reason to join CDIO. This category had the smallest amount of hits, but still there were a number of reasons listed that clearly show that CDIO approach is not difficult to understand and use. The applications underlined the non-complexity i.e. simplicity of the CDIO approach by saying for example:

- *The CDIO has 12 standards which serve as guidelines for educational program reform*

- *The CDIO standards and framework can help us be more systematic in reviewing our programs*
- *The CDIO model has a comprehensive and logical methodology for imparting to the students a broad base of knowledge, skills, and attitudes necessary to become successful young engineers*
- *The CDIO could give a solid and structured approach to further catalyze our development work*
- *The CDIO initiative provides a framework with clear standards that can guide the designers of the curriculum to achieve their goals*
- *Supplies a systematic setup for both documentation of the programmes as well as defining the type of programme.*

Some applications stressed that CDIO is clearly focused in engineering education and thus it is easier to understand:

- *The CDIO framework is a good model for engineering education that stresses product lifecycle:*
- *The CDIO approach is clearly focused on engineering students.*

Reasons to join CDIO: Trialability

Only 15 % of the reasons to join CDIO initiative were categorized to "Trialability". These reasons formed four additional groups dealing with staff inspiration, standards and syllabus, framework for activities and going beyond engineering education. The applications emphasized CDIO as a framework for their activities, a framework to try CDIO:

- *The CDIO framework provides a detailed and wellstructured guide*
- *The CDIO initiative provides us with excellent tools and methods*
- *These efforts are greatly helped by a systematic framework for education development.*
- *And CDIO offers a concise framework for new curriculum development*
- *Membership of CDIO would provide a structured framework for the future teaching within the Department of Engineering*
- *Gives us the perfect framework to develop our program so that we can provide our students with skills and competences they need to be able to compete on global work markets.*

Many applications underlined the role of CDIO standards and syllabus too to start using CDIO:

- *Syllabus to provide them additional value*
- *Its syllabus helps us to truly support students in the development of their professional identity.*
- *We see that CDIO standards are the powerful and helpful manual for the education improvement and reforming.*
- *The CDIO has 12 standards which serve as guidelines for educational program reform.*

The applications mentioned staff inspiration and testing CDIO outside engineering programs as reasons to join CDIO too:

- *Furthermore it will inspire staff and students to improve the quality of teaching and learning at the university.*
- *Apply the CDIO standards and skills to the engineering programmes but also to the degree programmes that are not traditionally referred to as engineering programmes.*

Reasons to join CDIO: Observability

Category "Observability" was the most common category of reasons found in the applications. These reason focused on learning from the others, sharing own experiences, visibility and availability of information, and network of universities sharing the same idea of education development.

The applications underlined learning from the experiences of the universities/programs which have been doing CDIO several years already:

- *We are interested to learn from the best practices and innovative ideas from the collaborating partners in the CDIO organisation*
- *To learn from leading engineering educators worldwide*
- *Gain from the wider perspective of CDIO and experience from other institutions*
- *The association with CDIO is the best choice for us to obtain new experience from leading engineering educators on a world scale*
- *Benefit from the extensive experience of CDIO leaders*
- *We also believe that membership in CDIO will provide us with a broader perspective on Engineering Education.*

At the same time many applications emphasized their willingness to share their own experiences and to contribute to the CDIO network:

- *We also believe that our university's unique character and geographical position in Russia will allow us to make a significant contribution to the CDIO network*
- *We have also something to give to the CDIO community.*
- *We will be able to test our ideas for innovations by sharing them with CDIO partners.*
- *We are ready to share our experience and to develop it with the CDIO participants.*
- *To share the experience with the other universities*
- *The CDIO framework gives us an appropriate environment to share our experiences.*

The applications highlighted the visibility and openness of CDIO initiative. Information on CDIO is available and background investigations are possible before making the decision to apply CDIO membership. The applications provided followings statements regarding these ideas:

- *After doing research on CDIO for over a year*
- *There have been much successful experiences showing that the CDIO approach is practicable and executable.*
- *The CDIO framework is also tried and tested in tens of universities within a long period of time.*
- *It has been an effectively international initiative to reform the education of undergraduate engineers.*
- *CDIO initiative is used globally*
- *Furthermore we liked the philosophy of sharing knowledge, cases and experiences with other universities and we like to become a member of this global initiative.*
- *Our cooperating partners participate actively in the educational programmes.*
- *When we read the first documents about CDIO we found that there are many structured responses to our educational needs.*

Finally, the importance of a large network sharing same ideology of engineering education was emphasized as well:

- *The CDIO connects together many universities or schools of engineering sharing the perception of what the main engineer's skills should be*
- *Working together with the community*
- *To join CDIO so that we can learn from and contribute to the approach with other like-minded schools.*
- *We wish join a network where we can meet people with similar ideas, share experiences and find ways to continuously improve our education programs,*
- *An existing network where experiences and ideas can be shared and discussed is considered to be a very important aspect of joining the initiative.*
- *The CDIO initiative provides collaboration with schools having a similar philosophy and approach.*

DISCUSSION

The applications of universities applying the CDIO membership provide interesting information on the reasons why they are joining CDIO initiative. This information is interesting for those universities that are thinking about applying CDIO initiative. They can study the rationale other universities used and they might identify new viewpoints with their application too.

The reasons categorized well into the general characteristics of an innovation as the CDIO initiative was understood. The study shows that the reasons universities have in their applications are pretty similar. However, there are differences on how universities emphasized their reasons to join the CDIO initiative. Three major categories represent almost 80 % of the reasons. One of the key reasons to join CDIO is observability which can be understood as learning from the others, sharing own experiences, visibility and availability of information about CDIO, and becoming a member of a network of universities sharing the same idea of education development. Another major reason to join CDIO is the CDIO initiative's compatibility with the university's own vision on education development and with the development actions already taking place. The third major category of reasons to join CDIO is the relative advantage universities are looking to achieve through CDIO initiative. Universities see the CDIO initiative as suitable and superior for engineering education. They are looking for remarkable impact on their programs and overall development. Furthermore, the universities see that the CDIO initiative is not a complex system rather it can be easily understood and tools such as the CDIO standards and the CDIO syllabus are simple to work with.

The study offers interesting information for universities that are already CDIO members too. These universities can reflect their own membership on the reasons that the new universities see important. Based on this information the current CDIO members can analyse their activities in the CDIO network. They can be more active in the network, they can focus on their actions in areas that are seen important and they can communicate the CDIO initiative better to new universities too.

For the CDIO leaders, the study showed how applying universities perceive the CDIO initiative. It seems that the perception is quite positive and correct. The elements CDIO initiative is emphasizing are seen important in the applications too. The CDIO initiative aims for better engineering education by providing a system and tools i.e. CDIO Standards (Bennedsen, Georgsson, & Kontio, 2016; CDIO, 2017a) and Syllabus (CDIO, 2017b) to support quality enhancement. The CDIO initiative is a network of universities and active individuals that share the same enthusiasm of improving engineering education.

CONCLUSIONS

The study identified the key characteristics of the CDIO approach that are attracting new universities to join the CDIO initiative – which characteristics are important and relevant to the applicant. These characteristics are presented below in the table 3. Each characteristics of the CDIO approach are connected with the characteristics of an innovation.

Table 3. The key characteristics of the CDIO approach.

Characteristic	Key characteristics of the CDIO approach
Relative advantage	Suitable and superior for engineering education Remarkable impact on the development
Compatibility	Similarity to university vision Connectivity with earlier development activities
Simplicity	Easily understood Focus on engineering education Tools for development (Standard & Syllabus)
Trialability	Inspires staff Standards and syllabus available for testing Framework for development activities Not limited to engineering education
Observability	Network to learn from the others Network to share own experiences Visibility and availability of information Network of similarly-minded universities

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BIOGRAPHICAL INFORMATION

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