Applying Change Management Theory in Developing CDIO-based Curriculum at Universities in the Vietnamese Ministry of Transport

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The society in which we live is becoming an information and knowledge society and global economy, which requires building a 'thinking' workforce. For universities, this means that the context of teaching has changed, with great interest and high demands from the community. Universities are put under pressure to provide their students with training for learning outcomes of internationally required knowledge, career skills and attitudes. This means that there is a need for an important change in thinking and practice in operating the university. The burden of great responsibility requires a reorganisation of university operating activities, including changes in the governance structure, teaching methods and curriculum development, and clearly defining learning outcomes. Higher education has experienced considerable change due to the Industrial Revolution 4.0, which is a result of the digital world. Universities must have access to the advanced curriculum development methods adopted by education quality management associations. The CDIO approach is one of the leading advanced methods of developing higher education programs currently being implemented by technical universities. This article focuses on applying the theory of change management in education to develop CDIO-based training programs for universities in the Vietnamese Ministry of Transport.

Key words: *CDIO based curriculum, education 4.0, change management, higher education, Vietnamese Ministry of Transport universities*

Introduction

Change is a natural process. The society in which we live has been constantly changing to move towards a global society and a knowledge economy that requires high-quality human resources.

With the teaching and learning landscape changing, universities need to constantly innovate in their executive functioning and practice. The task of directing educational innovation in universities can be done from the perspectives of various management theories, and one of the theories that receives the most attention and research is change management (Hayes, 2018). In the context of rapidly changing environment, due to the progress of science, technology and information technology, each individual or organisation is forced to adapt. Change management in leadership theory has been evaluated with high theoretical and practical value, not only for Eastern nations, but also for those in the West (McCaffery, 2018). For the past decade, this theory has been used to foster leadership, key management skills for leaders, management in the fields of economics, politics and education and social management in many countries, including Vietnam (Hoang & Pham, 2019).

Management was born from the needs of all social regimes, in every nation and at every age. The term 'management' has become popular, but there is still no unified concept. Scientists have come up with many management concepts from different perspectives: Taylor (1856–1915) was a proponent of 'scientific management', which proposed that managing was knowing what you wanted others to do, then ensuring they could do the best and cheapest job. Management activities in any organisation also involve basic activities related to planning, organising, directing and checking functions based on information gathering and processing (Holmes, 2016).

The structure of a management system can be represented by a simple diagram, shown in Figure 1. Management is one of the five agents of socio-economic development – the others are capital, resources, labor resources, science and technology. Of these five actors, management is crucial to success or failure. The people in charge of management must fully integrate professional knowledge and quality, and be equipped with management knowledge. They must set clear and brave goals and be determined to run their entire organisational system with a system of management measures (Robertson, 2015).
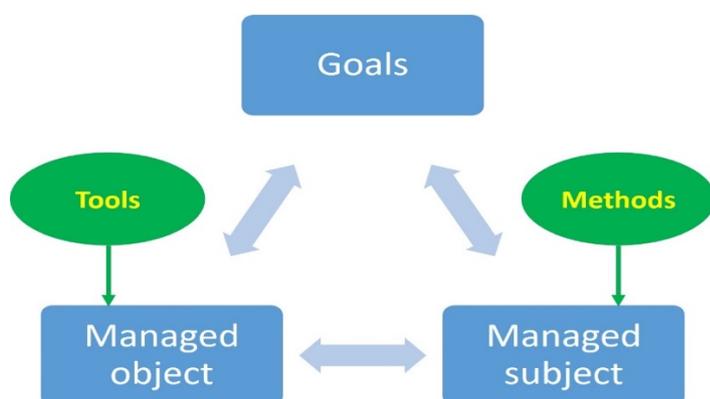

Figure 1. Structure of change management system (Robertson, 2015)

We are living at a time when changes in politics, law, the economy, society, science and technology are happening faster than ever before, and having a greater impact on our daily lives. We can neither resist change nor ignore it. In most cases, change is an inevitable process, integral to every aspect of social life. This is due to the interaction and internal and external factors of things and phenomena. Change is a common attribute of any object or phenomenon in the objective world. For an organisation, change can be positive because it entails adapting, surviving and developing, or it can be negative because it can cause disturbance, or adversely affect operations and activities within the organisation. Education in general and universities in particular face urgent and continuous changes. Positive changes can be 'ordered' by the state and society for education and universities. It is also possible that the university itself recognises that change is necessary to grow. The mission of university presidents is to capture change and control it to minimise the negative effects that change creates, adjusting it in the most beneficial way for the university. The presidents must be the leaders of change, managers of change and pioneers in implementing change (Nguyen, 2019).

In Vietnam, university management from the perspective of 'change management' is still a relatively new issue, but it has also attracted the attention of many scientists. In recent years, a number of researchers in Vietnam, especially educational management officials, have adopted a change management approach. They pay attention to strategies for making effective changes in teaching quality, and especially to the need for change in teaching activities to meet the requirements of educational practices. According to Harrison (2018), 'Educational management is a set of planning measures, to ensure the normal operation of agencies in the education system to continue development, expand the system both in quantity and quality.'

Education management in a general sense is the coordinated operation of social forces to promote the training of young generations in accordance with social requirements. Changes in the field of education and training at universities occur to meet the requirements of educational innovation in a new context (Dennison & Shenton, 2018). These changes, through the legal document system directed by management levels from the Ministry of Education and Training and other ministries, should be actively managed by university presidents: (1) managing change in educational and teaching goals; (2) managing change in curriculum content; (3) managing changes in educational and teaching methods; (4) managing change in the form of education and teaching; and (5) managing change in testing and evaluating education and teaching results (Asuga, Scevak & Eacott, 2016).

Training programs are a basic component of the training process. The quality and effectiveness of the training process depend greatly on the structure and content included in the training program. There are many views on the training program, one of which comes from McDonald 'The training program is an overall blueprint for a training activity, indicating the entire content of the training, specifying what can be expected of learners after the training, outlining the

necessary process to implement the training content, training methods and how to test and evaluate learning results and all of them are arranged in a strict schedule' (McDonald, Goodwin, Pradhan, Romoser, & Williams, 2015). According to the Law on Higher Education 2013:

> Training programs at college and university levels include: objectives, standards of knowledge and skills of graduates after graduation; training content, evaluation methods for each subject and discipline, training level; ensure interconnection requirements between qualifications and other training programs. Higher education institutions are autonomous and self-responsible in developing, evaluating and promulgating training programs for college, university, master's and doctoral degrees. (Watts et al., 2017)

The technical education programs in most countries of the world are the product of the development of technical education in the last half-century. In those years, these programs have shifted from hands-on education to a science-technology training model. The goal of this change is to equip students with a solid scientific foundation to meet the technical challenges that may be encountered in the future (Chen, Tabssum & Nguyen, 2019). At the same time, this change led to a shift in the technical education culture, which reduced the value of the skills and attitudes that had been considered the standard of technical education until that time. Since then, a conflict has arisen between a theoretical curriculum and a practical curriculum (Dennison & Shenton, 2018). The challenge now is to change this conflict to meet the needs of stakeholders outside the university to reform the program and the method of education to transform the culture of education.

Integrated training is a common trend in current types of education. An integrated training program is built on the basis of integrating goals and training contents that are closely related to each other in a unified whole, in which students learn, practise skills, develop personal qualities, build coordination skills and core skills of the major (skills to apply professional knowledge into practice), and hone CDIO-operated competencies at the same time as acquiring the knowledge. The integrated training program is a systematic set of subjects designed from an integrated perspective, forming a unified whole. In this training program, the system of knowledge and basic skills is intertwined with the professional career; there is no traditional boundary between them. Integrated learning is represented by learning each subject through topics. Integrating and conducting practical activities occurs according to an integrated roadmap (Teng, 2016). Integrated teaching and learning must aim at the learning outcomes of each subject/module and be appropriate to the level and cognitive capacity of students; it must also be built on the basis of classifying learning goals. Lecturers build learning scenarios that integrate knowledge, skills and ethical standards to meet the specific requirements of occupational labour. Facilitators guide students to participate in situations, simulations and

role-play to solve work and other professional and practical activities to meet the learning outcomes of the subject (Li, Luo & Zhao, 2018).

CDIO represents a comprehensive solution to the challenge of improving the quality of training to meet social needs based on determining learning outcomes to design training programs and methods according to a scientific process. CDIO is a new initiative for education, a system of methods and forms of accumulating knowledge and skills in training students to meet the requirements of business and society. This article presents the changes that took place during the development of the training program towards CDIO development approach in universities in general and universities in the Ministry of Transport in particular.

Theory and Methodology

Change Management

The Concept and Characteristics of Change and the Relationship between Change and Development

All phenomena in life are constantly moving and changing. That is the objective truth and immutability. People live with constant change. In life, every person undergoes natural change, from birth to adolescence, and adolescence to ageing. Every organisation goes through stages: formation, operation, development or disintegration, and these phases occur with changes at many levels, both in policy and practice. Change affects every aspect of life, so finding an approach that is appropriate for change is the best way to keep up with the changes of tomorrow (Hassi et al., 2016). Change is an important factor related to the success of an organisation, and adapting to the ever-changing presence is essential for future success.

In organisational management, change can be an opportunity for organisational development, leadership capacity development and staff management skill development in the organisation. For organisations, the process of change will refresh the organisation, improving competitiveness, expanding operations, and improving productivity and product quality. At the same time, it changes the way management and leadership are done. Relevant leadership is the motivation to organise activities more effectively (Pugh, 2016). For managers, change is an opportunity to develop leadership and management capacity. After each change initiation and implementation, the manager has additional change-management skills and experience (Morden, 2017). Change is not only a responsibility for managers; it is also a challenge and an opportunity. For example, when accepting an under-performing organization, it is important for the manager to make changes to ensure the organisation will work better. That job is not easy. And when managers successfully implement the change, it is clear that they have created a reputation and position for the organisation as well as their organisational system, including

society. If change fails, then it can give managers experience, knowledge and skills for better management in the future (Phuong & Pham, 2019).

For employees, change is the opportunity that managers bring to employees to realise their own ability to work. Working in groups sometimes makes employees feel sluggish, and they can even come to believe that there is no other way to do their job; therefore, they feel they have no other ability. When change occurs, employees have the opportunity to realise their other capabilities. Change will create many new issues, stimulate debates and develop the working capacity of all employees. Managers need to clearly identify the important milestones of the process, when the development stage is over and the actions begin (Sartori et al., 2018). Development, which is different from change, is a process that is implemented under relatively stable circumstances. Change in itself implies instability, but this is the time to create many new talents, especially during the transition period (Dong & Pham, 2019).

Change Management Principles

Change management is a necessary and meaningful issue, which becomes an art form for managers. The mission of managers is to capture change and adjust it in a way that benefits the organisation. As Peter Drucker, a leading management consultant, said, 'Successful people must be the ones who welcome change.' Change is wasted if it is not recognised and implemented properly. Considering the process of change management, James Harrrington said, 'Change management not only applies to our organization but also a concept that can be applied to everything we do. Managing the cost, schedule and quality of the project is not enough, without the project's social impact management, most projects will not reach their full potential.' To minimise the negative effects of change on the organisation, change management is needed (Rothaermel, 2017).

Principles of change management include: (1) building trust in people to create consensus in the process of change management; (2) managers being pioneers in implementing change plan; changing themselves before asking others to change; (3) all organisation members being responsible for change; (4) choosing the issues and areas to change in accordance with the conditions, circumstances and capacity of the organisation; (5) ensuring the stability of inheritance and development – a 'dynamic equilibrium' must be ensured during the change process (McDonald et al., 2015).

The Nature and Arguments of the CDIO Approach

The CDIO approach is a theoretical model of output-oriented training in technical universities. This theoretical model provides a scientific basis and a system of quality standards to ensure that higher education institutions solve two key issues: (1) What comprehensive skills and attitudes should technical students gain when leaving a university, and at what competence level? and (2) How can

we do better in ensuring students achieve those skills? These are also issues that need to be addressed for higher education in general and technical training in particular around the world in the context of knowledge explosion, industrialisation, internationalisation and other global issues (Salleh et al., 2019). Revising and updating the curriculum enables students to maintain pace with the changing needs of society. It is also essential to build the right foundation for learning, so learners can handle the complex problems of modern knowledge and practice that are an inevitable trend of world education (Phuong, 2019).

To address these issues, the CDIO model mentions 12 standards that fully reflect the training process and manage the quality of training in the direction of technical education reform. These standards address the program's philosophy (Standard 1), program development (Standards 2, 3 and 4), design implementation experiences and learning spaces (Standards 5 and 6), new teaching and learning methods (Standards 7 and 8), teacher development (Standards 9 and 10), and student assessment and curriculum evaluation (Standards 11 and 12). Of these 12 standards, seven standards (marked with * below) are considered essential because they distinguish CDIO programs from other education reform initiatives. Five other standards significantly support the CDIO program and reflect best practices in technical education:

- *Standard 1* Background.* This standard derives from the principle of the development and implementation of a product, process and system lifecycle, conceptualisation, design, deployment and operation as a technical education context.
- *Standard 2* Learning outcomes.* Details specific to personal and interpersonal skills, product creation processes, processes, systems and professional knowledge must be consistent with the program objectives and approved by the program's stakeholders.
- *Standard 3 Technical training.* Programs are designed with specialised knowledge courses that support each other, and have a clear plan for integrating personal and interpersonal skills, products and process-building skills.
- *Standard 4 Introduction to technology.* An introductory course provides a framework for engineering practice in creating products, processes and systems, and the introduction of essential personal and interpersonal skills.
- *Standard 5* Design-implement experiences.* A course needs to include at least two design-implementation experiences, including one at the basic level and one at the advanced level.
- *Standard 6 CDIO learning space.* Technical workspaces and laboratories support and encourage hands-on learning in creating products, processes and systems, specialised knowledge, social studies.
- *Standard 7* Integrated learning experiences.* Integrated learning experiences lead to the acquisition of specialised knowledge as well as personal and interpersonal skills, product, process and system-building skills
- *Standard 8 Active learning.* Teaching and learning are based on the active experiential learning method.

- *Standard 9* Capacity of lecturers on CDIO skills.* Actions are taken that enhance faculty competence in personal and interpersonal skills, product, process and system-building skills.
- *Standard 10 Enhancing lecturers' competence in teaching skills.* These actions enhance the ability of teachers to provide integrated learning experiences in the use of active experiential learning methods and in student learning assessments.
- *Standard 11* Assessing students' learning.* Students' learning on communication skills, product creation processes and systems and specialised knowledge is evaluated.
- *Standard 12 Evaluation of CDIO program.* A program accreditation system follows these 12 standards and provides feedback to students, faculty and other stakeholders for the purpose of continuous improvement.

Figure 2 describes the process of modelling the CDIO approach in detail. From the experiments that have been applied successfully in technical education both in the world and in Vietnam, the CDIO model is also applicable to programs outside the technical field for continuous and comprehensive improvement (Muhammad et al., 2018). According to experts, the benefits of training under the CDIO model are:

- aligning the training institution with the requirements of the employer, thereby closing the gap between the school's training and the requirement of the employer using human resources
- helping learners develop comprehensively with 'hard skills' and 'soft skills' to quickly adapt to an ever-changing working environment and even be at the forefront of that change
- helping the construction and design of a standard process
- ensuring that the stages of the training process are interconnected and linked with science
- associating the development of training program with the transfer and evaluation of the effectiveness of higher education, contributing to the improvement of higher education quality (Huang, Wang, & Zhu, 2016).
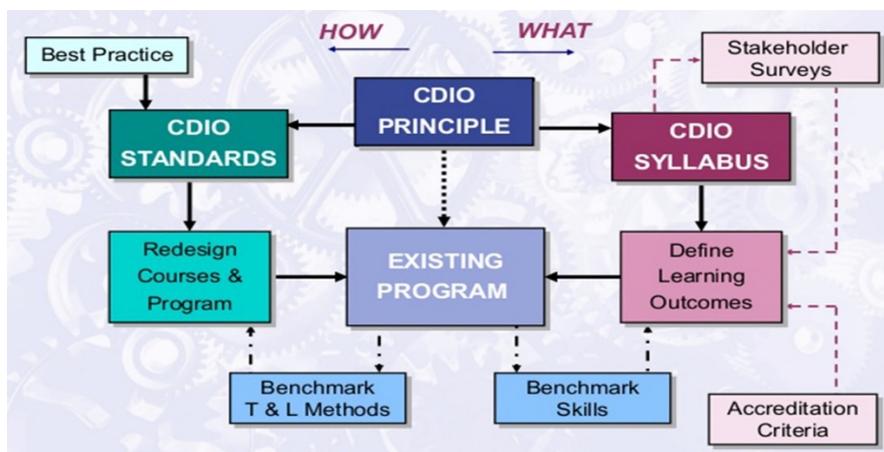

Figure 2. The process of development of CDIO approach (Muhammad et al., 2018)

Applying Change Management Theory to Control Innovation in the University Curriculum

Change management is essentially planning, operating and directing the implementation of change to achieve the goals set for that change. We often use the word 'innovation'. Change can feature innovation, but not eliminate the possibility of bringing new things into operation or changing a stage in the process of implementing an activity. Developing a training program based on the CDIO approach at university level in the technical sector is a new, objective and urgent issue in the process of renewing and improving the quality of Vietnamese higher education. Because there are many different perspectives and conceptions about approaches and competency-based education and training program development models, in-depth and comprehensive studies on the above issues are necessary to apply the CDIO approach appropriately to the program development requirements (Schedin & Hassan, 2016).

To develop training programs based on CDIO approach in technical disciplines at university, to improve training quality, meet social needs and to manage the change in curriculum towards the CDIO approach, 11 steps need to be taken, as outlined below.

Step 1: Identify the Change

Being aware of what training curriculum innovation will relate to, it is crucial to answer the following questions when a 'change' manager applies to directing the innovation of a school's curriculum: At what level do the status of the school and the habits and inertia of the school's lecturers on the issue of renewing the curriculum at their school exist? What are the advantages and disadvantages of awareness and ability to implement the policy of renewing the training program at the school? Who should start the innovation of the curriculum at the school? What steps are most realistic for the innovation based on the conditions of the school?

Step 2: Prepare for Change

In order to implement this step, university managers must find answers to the following questions:

- How do people share the policy of renewing training programs and changing habits, breaking the 'inertia' of old habits, re-creating and making them feel that the program is innovative? Is training an imposed policy or a need to affirm the quality and effectiveness of a training process or a pedagogical methodology?
- Should we start by discussing the curriculum innovation or by encouraging 'small sparks' and following the 'oil spill' direction, choosing a major or department with a leader to devote themselves to and be able to build a 'pioneering – modelling' which encourages

people to gradually participate in the renewal of training programs or to thoroughly grasp the policy of renewing training programs in the period? Is it now urgent for the university and the key staff to make all teachers understand that policy?

- Should we encourage lecturers to attend seminars and training courses on the development of CDIO-based training programs taught by experienced and prestigious training program managers? Must university managers carefully study the renovation of their school's curriculum, the direction of superiors and the effects of renovating the training program and guidance process to give themselves enough knowledge to guide this issue in university practice?

Step 3: Collect Data

This is a 'preparation of action' step, so the manager must find answers to the following questions: What is the situation of school staff (quality of staff, professional sense, and spirit of innovation? What is the situation of equipment and teaching conditions of the school (quantity, quality of provided equipment, teaching aids and their exploitation for teaching)? What understanding is there of curriculum innovation in teachers of the school? (Who has been trained in teaching innovation, who has innovative teaching initiatives?) It is necessary to implement the following activities: collecting training materials to renovate training programs; finding organisations or advisors who support the curriculum innovation (McCaffery, 2018).

Step 4: Find Incentives to Support Change

There is an incentive to find some typical personnel with positive enthusiasm to participate in the renovation of training programs in schools to stimulate the movement. This step should include facilitating teachers who have good teaching achievements or are enthusiastic about learning about the renewal of training programs to visit or attend training courses and training of educational projects in international organisations. Whenever possible, it is advisable for change managers to maximise responses to all requirements of the volunteer teacher at the forefront of renewing the curriculum and teaching methods. Creating a mechanism to support resources and encourage the renewal of teaching methods and training programs should also be thoroughly considered (Ramos et al., 2015).

Step 5: Define Specific Goals for the Steps to Direct Change

Defining long-term and specific goals for each activity and each period should be done in the following sub-steps. First, define the goal in the pilot step to consider the ability to apply the idea of renewing training programs for a few departments or institutes with good traditions and achievements. The next sub-step will occur after successfully analysing the failures of the pilot step and selecting the next step. Reviewing the implementation progress that is appropriate for

each stage should then occur. However, all these sub-steps should be closely related to persevering with the ultimate goal of putting the training program innovation into an annual action plan and making it last with the existence of organisations (Dasborough, Lamb & Suseno, 2015).

Step 6: Determine the Focus of the Goals

The focus of the goal is to innovate the effective implementation of the familiar, old training program and to apply new training programs to the CDIO approach, step by step. Constantly improving the way of organising class hours in a positive pedagogical way is one stimulating step. Utilising the role of teaching aids to enhance the effectiveness of student awareness and improve the quality of class hours is another (Cameron & Green, 2019).

Step 7: Review the Solutions

Generally, directing the renovation of manager training program to use some promotion solutions should answer the following questions: Is it worth encouraging personnel spirit or material, or a combination of both? Should the solutions involve close guidance of specific requirements for each lecturer involved in renewing the curriculum in specific subjects or specific teaching hours? How about timely and objectively assessing the implementation level of the contents and targets set for each activity and each stage? Should commendation, criticism and rewards be timely and fairly tied to performance? The focus should be on putting weight into solutions in the context, to fit the current development period of the university.

Step 8: Select a Solution

Choosing the right solution is always difficult; however, the optimal solution is one that is both suitable for management's ability and feasible under specific circumstances.

Step 9: Making a Plan to Direct the Implementation

The issues that needs to be considered are how methodological innovation guidance should be initiated and what direction management at the university level should take to ensure coherent, synchronised, uniform and plausible innovation. The following issues should be noted in directing the training program renovation. It is important to thoroughly understand the guidelines (disseminating the documents guiding the renovation of the educational program of the educational management level). It is then advisable to discuss the capabilities and measures required to implement the policy of renewing training programs at their schools for registration or designation of score takers (according to the above-mentioned target orientation). How should conditions be created for lecturers to renovate the curriculum to the subject level? What

are the criteria for organising the evaluation hour of learning experience? Should typical replication be done by grade level or by subject? What are the optimal measures to maintain the movement of renovating curriculum and teaching methods in a sustainable manner? At what level is it suitable to analyse, evaluate and draw experience to plan the innovation of teaching methods and training programs for the following academic years? When planning to make a change, it should also be kept in mind that the smallest details can sometimes ruin the big deal.

Step 10: Assess the Changes

Changing the perception of how the training curriculum has been reformed is vital, including the supporting level, feasible action, level of innovation awareness, and number and percentage of people who have changed their perceptions and are willing to innovate. This step includes changing how lessons and class planning are carried out in the direction of renovating training programs, changing the way the teaching time is organised in a positive pedagogical way, changing the way students perceive results and changing the method of evaluating a good teaching hour then a good training program.

Step 11: Ensure continued innovation

Everyone is aware that curriculum innovation is the task of teachers when implementing curriculum and teaching materials. The majority of lecturers must be encouraged and mentored in how to implement the transformation of training programs and teaching methods.

Designing an Integrated Training Program Based on the CDIO Approach

The CDIO approach specifically explains the theoretical and practical basis for forming an integrated training program. In practice, in the context of strong development of science and technology, adding content or increasing the training time in traditional teaching programs to meet the standard of training can be very difficult. It is therefore necessary for a training program to be able to take advantage of both time and resources in existing specialised subjects, which means taking advantage of the combination of the simultaneous study of specialised skills and knowledge. A detailed explanation for the rationale of an integrated education program and outline of the key characteristics of an integrated education program is provided in Figure 3.
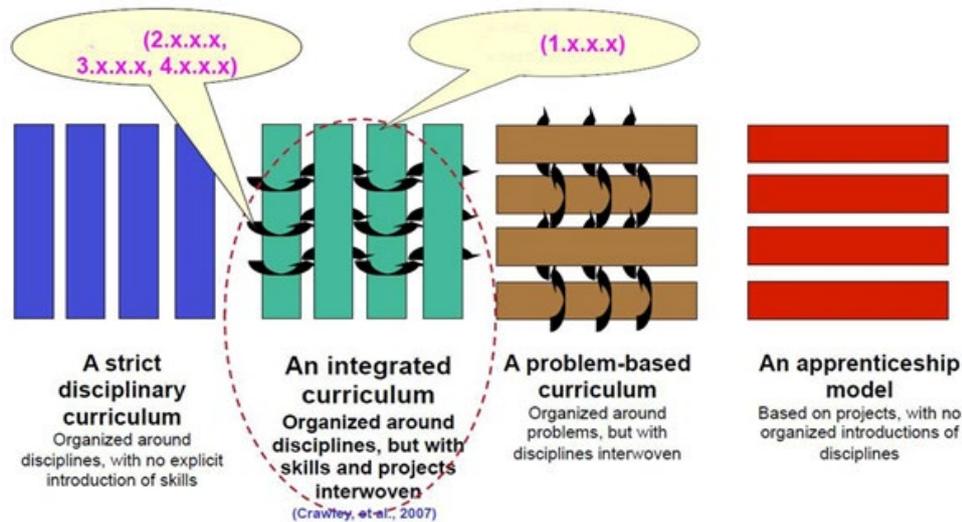
Figure 3. An integrated curriculum (Hyland et al., 2018)

The educational program is organised around specialties and restructured so that majors can connect and support each other, as opposed to being separate and independent of each other. Personal and interpersonal skills, product-creation skills, processes and systems are intertwined in disciplines that are mutually reinforcing in order to resolve the potential conflict between this technical expertise and these skills. Each subject or learning experience sets out specific disciplines about specialised knowledge, personal and interpersonal skills, product, process and system-building skills to ensure that students have the right platform for their future as engineers (Hyland et al., 2018).

In the process of developing higher education programs, people focus on the content and structure of the program; however, more attention should be paid to transforming the training process, innovating teaching and learning methods of learners, improving teaching facilities and the process of evaluating and confirming learning results. Integrity of the program will be reflected through its content, structure and training method as detailed below.

1   The integrated education program emphasises creating learning projects where there is integration of knowledge, interdisciplinary, multidisciplinary and personal skills. Through participation in learning projects, learners are allowed to experience and formulate standards of knowledge and skills to meet social requirements.
2   In an integrated program, the source of knowledge will not be framed within the framework of modules/subjects, but it should be always transfer beyond textbooks, creating openness in cognitive-learning activities.
3   The integrated education program helps learners to be aware that learning is becoming more and more flexible. Learners actively participate in learning project resolution groups and are proactive in solving academic tasks and releasing creativity through open tasks,

and integrating professional, interdisciplinary, multidisciplinary and personal skills. Through the integrated education program, learners are encouraged to consciously solve problems by themselves, to enable practical and social knowledge to be applied in the learning process and to participate in a comprehensive education process.

4   The integrated program also enables learners to participate in flexible student groups in the same industry when dealing with narrow, deep professional tasks. There are also interdisciplinary teams to address tasks that require the integration of knowledge and skills in many disciplines, or multidisciplinary, advanced, and multidisciplinary teams to address the tasks of interest and approaches of various sciences. The CDIO initiative also describes the process of designing an integrated training program. This process respects the pre-existing conditions and the resources available to create the characteristics of each program. However, this process also proposes appropriate approaches and options to design the curriculum to better support students' learning.

5   The process of designing the curriculum is shown in Figure 4. This model represents the transformation of the 'CDIO' vision into a formal set of goals that underlie the design of the curriculum. This conversion is based on the desired outcomes, pre-existing conditions and matching training program. Next, the design of the curriculum is itself defined as an expression of the goals in the subjects and relevant learning experiences that formally form the curriculum. The proper design of the training program will start with two parallel steps, which will gradually interact with each other to design the curriculum structure and determining the appropriate teaching sequence for each topic, and then adapt the sequence to the elements of the structure, so each element bears clear responsibilities for student learning in an integrated design in a mutually supportive and coordinated manner.
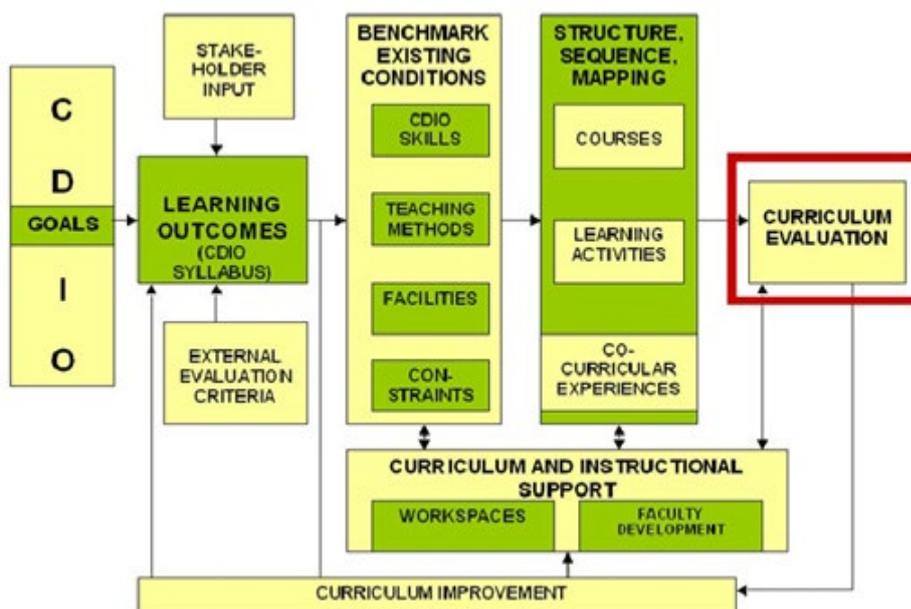

Figure 4. The integrated CDIO-based curriculum

The outstanding advantage of CDIO is that it does not have a rigid principle. Training disciplines can therefore be flexibly adjusted to make them suitable for majors that are not in the technical area or in the university specialising in technical training. According to the CDIO approach, when developing training program it is required to strictly follow the procedures regarding formulation of training standards and designing program framework and how to convey it in practice; at the same time, there is a need to evaluate the learning results as well as the entire curriculum. The key of CDIO is to design the learning outcomes system in technical training based on competency approach, emphasising the capacity of the conceive–design–implement–operate model, value-added products, and cycled processes and systems, and to use these capabilities in a modern, team-based environment. On that basis, the design of an integrated training program to meet the learning outcomes is activated.

Figure 5 illustrates the structure of the integrated training program (professional education knowledge block). In general, an integrated training program includes the four subject types in Figure 5: introduction subjects; specialised basic subjects; specialised subjects; and graduate projects.
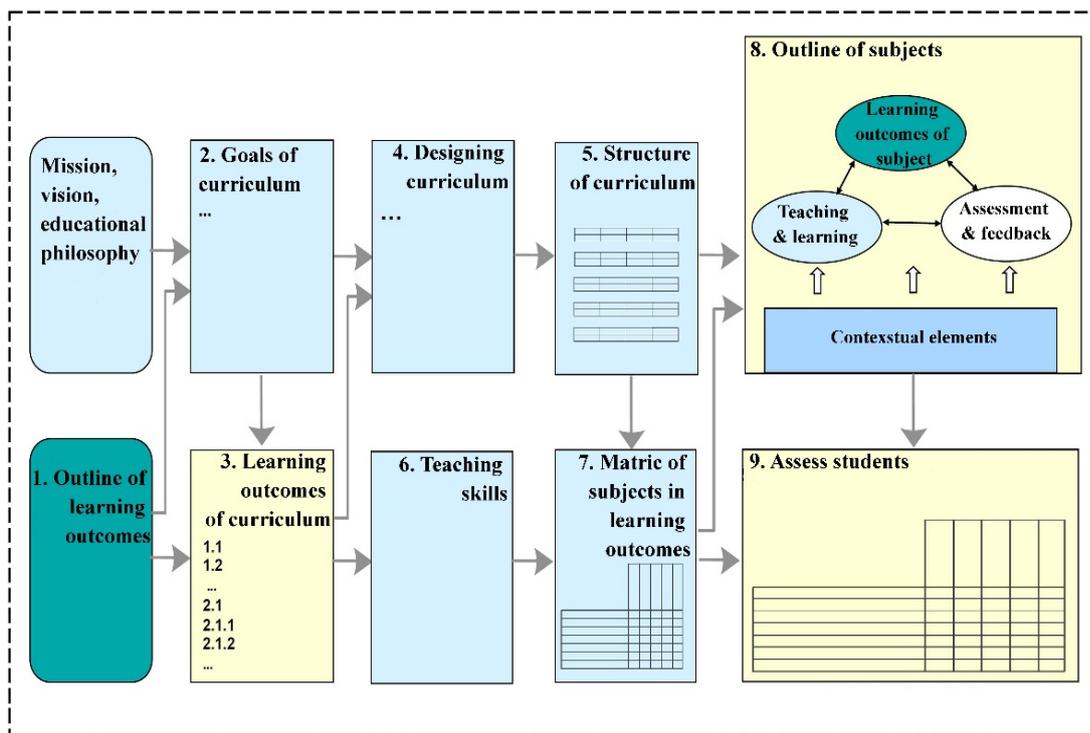

Figure 5. The process of CDIO-based curriculum development

The first part of the integrated curriculum is designed from specialised foundation and industry introductory courses to encourage students' excitement and motivation. The second part of the integrated curriculum – specialised subjects – includes relevant projects/research/exercises. These components often constitute the core of the program. Learning experiences are organised

into a number of different innovation structures that allow the process of integrating learning outcomes into personal skills, professional skills, product/project-building skills and the learning outcome of specialised knowledge. The third and fourth sections of the training program include intensive subjects, optional and compulsory subjects, or graduate projects, and design and implementation experience. As the number of specialised subjects for students increases in this part of the program, integration of skills will become more difficult. During these phases, it may be best to focus on design/project subjects – integrated implementation, in which a number of diverse innovation structures can provide flexibility in length of time and the sequence of learning experiences. From practical experience of developing a training program under the CDIO approach in Vietnam, a CDIO-based training program should be implemented using the following steps:

- *Step 1– Matching the current training program with the new learning outcome.* Learning outcomes are the basis for the design of training program. Therefore, to complete a training program, the first step is to match the current training program with the desired learning outcome.

- *Step 2 – Designing the training curriculum and restructuring training program according to new learning outcomes and new ideas.* In this case, the training curriculum is designed to match the principle of integrated training program, as mentioned above. Applying an integrated curriculum structure allows full use to be made of the allocated time and the creation of conditions for students to develop in both professional knowledge and necessary skills and attitudes, as required by CDIO Standard 7. The training program is thus organised according to the subjects, and interwoven with it is a great exercise and a project for students to practise their skills and attitudes. The content of the subjects should be considered so that there are links and support between the subjects. The result of this step is the new curriculum framework.

- *Step 3 – Designing a sequence to establish learning outcomes covering skills and attitudes.* The sequence of establishing learning outcomes through subjects is properly established, the learning will develop in a cycle, in which knowledge, skills and attitudes will be built and reinforced on the basis of the knowledge, skills and attitudes previously learned.

- *Step 4 – Allocating self-learning topics into the subject.* This process shows how skills and attitudes are intertwined in the subjects. The result of the allocation of teaching sequences is a subject matrix, in which one axis lists the subjects and the second lists the topics of the learning outcomes. Subject teachers need to be deeply involved in the process of designing teaching sequences and allocating sequences into the subjects to comment on the feasibility of integrating certain skills and attitudes into them and the professional content they are in charge of teaching. By participating in the design or completion of the training program, and through the edition and iterative stages, the instructors have the right to own the training program.

- *Step 5 – Designing the subject outline.* After agreeing on the allocation of the teaching sequence of the learning outcome topics to the subject, each instructor can design the course outline according to the assigned specialties for the subject. The process of designing a training program can be repeated many times. In the CDIO-based training program, each subject, at a different angle, contributes to achieving the standard of training of the whole program. Therefore, each instructor must abide by the program's standards and make commitments on the delivery of the subject's learning outcomes.

Conclusion

Internal and external resources for inevitable changes in all areas of university activity obviously include human resources, finance, facilities, training programs, teaching and educational activities, and the culture of the university. For the university to adapt, survive and develop to keep up with the development of other areas in modern times, university presidents and faculty deans need to proactively manage change through planning, organising, leadership and testing functions, focusing on training competencies and the quality needed to succeed in change management. In particular, the management of curriculum changes should follow a more advanced approach, such as the CDIO approach.

CDIO provides not only a learning outcome for the training course but also a clear guide to training and education management, such as methods of leadership, higher education management, developing teaching staff with in-depth expertise, closely connecting enterprises with higher education institutions, project-based, group-based teaching methods, reforming curriculum frameworks, providing informal communication skills, experiential and proactive learning, curriculum design, learning environment, testing, evaluation and internationalisation of higher education. It can therefore be said that CDIO is very useful in implementing an effective training program and is one of the solutions to improving the quality of higher education. Today, universities around the world are adopting the CDIO initiative, and its advantages and effectiveness have been confirmed and verified over time by many different universities.

The process and application of CDIO are new issues for universities in Vietnam in general and universities in the Ministry of Transport in particular. Currently, the universities under the Ministry of Transport, such as Vietnam Maritime University (since 2016), Ho Chi Minh City of University of Transport (since 2017), University of Transport Technology (since 2018) have been approaching CDIO. Initial implementation of the CDIO-based training programs in these universities still faces many shortcomings and difficulties due to limited resources and shortages of proper mechanisms. Access to CDIO requires the following basic conditions: adequate facilities, competent faculty and staff, students with good adaptation to new learning ways and technology. To meet the basic standards of CDIO, there must be a standard and

unified process system to ensure the success of the program. CDIO requires adherence to a rigorous regulation from practical surveys to identify social and business requirements for training products to the construction, design, organisation and evaluation of training programs. These are major challenges for universities under the Ministry of Transport, but this does not mean that change in curriculum is impossible. Changing awareness to take the right action in the application of CDIO will certainly bring practical effects for improving the quality of human resources for the national and regional transportation industry in the present and increasingly in the future.

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