

Original Article

Scenarios Presented in the Development and Implementation of the Dual Education Model in the TecNM according to the Perception of the Teachers-Tutors in Civil Engineering and Architecture 2015-2022

Noemí Parra-Buelna^{1,2}, Eduardo Arvizu-Sánchez¹, Gildardo Herrera-Sánchez^{1*}, Edgardo Suarez-Dominguez³, Juan Jesus Pecero-Moreno³, José Canto-Esquivel⁴

¹Faculty of Architecture, Design and Urbanism, Universidad Autónoma de Tamaulipas, CP.

²Instituto Tecnológico de Tijuana. TecNM. Tijuana, BC Mexico.

³Energy Instituto Universidad Autónoma de Tamaulipas, CP.

⁴Instituto Tecnológico de Mérida, Mérida Yucatán.

*Corresponding Author : gildardo@uat.edu.mx

Received: 13 October 2024

Revised: 15 November 2024

Accepted: 01 December 2024

Published: 26 December 2024

Abstract - In 2015, the Tecnológico Nacional de México implemented the Dual Education Model for Bachelor's Degree (MEDTecNM, by its acronym in Spanish). According to data presented in 2022 by the TecNM, the number of participating Technological Institutes has been increasing. However, it is still quite far from being a widespread practice, and it should be taken into account that implementing a model of this type takes time. It is not something immediate, so it is necessary to analyze the perceptions of the key participants, such as students, entrepreneurs, and, in this case, teachers-tutors, on the elements that facilitate or hinder the development of the system. The MED IT Tijuana has been implemented in the Architecture and Civil Engineering careers of the Department of Earth Sciences since 2015. The objective of this article is "To know the main factors that have conditioned the implementation of the Dual Education Model for Undergraduate Level (MEDTecNM) in TecNM Technological Institutes and particularly of the Technological Institute of Tijuana according to the perception of the participating teachers/tutors, in order to identify the presence of facilitating elements, barriers and present strategies for their implementation." To achieve the objective, two strategies have been followed: as a first step, a documentary analysis has been carried out using the information obtained from the application of the SWOT Analysis carried out in 2022 to teachers/tutors of Technological Institutes of the TecNM that have implemented the MED; as a second step, the design, validation and application of a questionnaire in 2023 to a representative sample of the participating teachers/tutors of the MED of the Technological Institute of Tijuana (IT Tijuana) in the careers of Architecture and Civil Engineering, of the Department of Earth Sciences, during the period 2015-2022. The results of the documentary research and field research are presented through the questionnaires made to the teachers/tutors who have been directly involved with the experience. Among the results, positive situations stand out. It was an initial experience in which all participants expressed high satisfaction with MED IT Tijuana. However, results have also been detected that denote a specific resistance when implementing the MED, such as teachers' training deficiencies about the model's lack of recognition of teachers' role as advisors or tutors. There are also not enough places for the number of young people who want to participate.

Keywords - Dual education model, Implementation, Teachers/Tutors, Higher education, Architecture.

1. Introduction

Training competent professionals committed to the socio-economic development of society is one of the great priorities of higher education systems [1, 2]. UNESCO, during the World Conference on Higher Education in Paris, underlines that the primary objective of higher education is "To train highly competent professionals and responsible

citizens, capable of meeting the needs of all aspects of human activity, offering them a preparation that is up to modern times, including professional training, combining high-level theoretical and practical knowledge through courses and programs that are constantly adapted to the present and future needs of society" [3]. Faced with the challenge of social and economic development, it is essential to offer alternatives that allow students to take greater



responsibility in their own academic training process and work experience by participating in the design and operation of projects for the solution of problems in the productive, business, and social context, promoting the development of professional skills [2, 4]

1.1. TecNM and Dual Model

The Tecnológico Nacional de México (TecNM) is a leading educational institution with more than 620 thousand students. With 254 institutions nationwide, it offers 43 bachelor's degrees, 13 specializations, 65 master's degrees, and 24 doctorates focused on key sectors such as agro-industrial, automotive, aeronautical, and energy. It represents the largest higher education institution in Mexico and Latin America, training 41% of its engineers. Its educational model seeks to provide higher education opportunities to all young people, support regional industrialization through the training of committed professionals, and contribute to national and regional development. By the founding decree of the Tecnológico Nacional de México, the Dual Education Model (MED) for Bachelor's Degree (MEDTecNM) is presented. This model, based on Article 2, seeks to be flexible and adapt to labor needs, promoting student learning and facilitating their transition to the workplace and business production processes [5]

Implementing the MED in the TecNM has been divided into two stages: the first, in 2015, refers to the deployment of the model to academic authorities, as well as training in the academies of most of the Technological Institutions of the Mexican Republic. At this stage, the first official criteria for applying dual education in all the Technological Institutes of the TecNM were published, thus becoming the leader at the higher education level in this field. Information has been collected since its inception to date, and diagnoses that led to an update in 2022.

1.2. Dual Model in TecNM Tijuana

As a systematic procedure, higher education institutions improve their educational models to achieve graduates who are better prepared and competent in the economic development of society and who can perform fully in the increasingly competitive professional and labor environment, which is characterized by constant transformation [6].

There is a wide diversity of models related to lifelong learning [7], grounded in acquiring meaningful knowledge in school, life, and work. This model advocates for work-based learning, closely related to the concept of learning by doing, akin to the logic of business systems. Work-based learning refers to various methods for developing skills and competencies linked to the labor market. [8]. Dual Education is an educational modality of teaching and learning in two distinct and complementary settings, in the classroom and the company [9, 10], primarily characterized by a cooperative link. The vision for developing human talent is to attain a

sophisticated level of development in the workplace, enabling individuals to compete as highly qualified professionals with intellectual, practical, and attitudinal qualities in the job market [11].

This model at the professional level has been implemented in European countries such as Germany, France and Spain, and in the Americas, Chile, Costa Rica, Colombia, Mexico, Canada and the United States, as a strategy to seek solutions to the disconnect between educational training and the needs of the labor market and to contribute to a higher quality academic preparation, increase the development of job skills, professional competence and to enhance the labor insertion of graduates [12].

The implementation of the MEDTecNM at the IT Tijuana in the Architecture and Civil Engineering programs is structured through a 10-semester generic curriculum. Starting from the eighth semester, students enter the specialization module, where they can choose to participate in the MED IT Tijuana "Operational Project Management" (in this case) through regional construction companies meeting the institution's criteria. The curriculum comprises 210 credits from the generic plan, 10 credits for community service, 25 credits for the specialization module, and 10 credits for professional residency conducted within the training company.

To begin the MEDTecNM, it starts with signing a collaboration agreement between the Technological Institute and the collaborating company. From 2014 to 2019, 97 students from the Architecture and Civil Engineering careers of IT Tijuana participated in 12 companies belonging to the CMIC (Mexican Chamber of the Construction Industry) Tijuana Delegation (see tables No. 1 and No. 2). Students from the eighth or ninth semester who were prospects to start the speciality module joined MED IT Tijuana from a call in which all the requirements were exposed. The employment relationship is full-time, carrying out work typical of the construction process in a company. In addition, students receive special refresher courses in the company itself and in the ICIC (Training Institute of the Construction Industry) during their stay in the company.

The Specialty Module in Dual Education in Operational Project Management is aimed at students enrolled in the Civil Engineering and Architecture educational programs offered by the Department of Earth Sciences at the Technological Institute of Tijuana. The module covers the life cycle of the construction project (projects and procedures, certification, quotations and execution and administration). The graduate profile of the speciality is aimed at a professional with the skills that allow articulating, with similar criteria, the construction project's planning with the execution and administration of the construction project. The MED IT Tijuana represents a success, as it trains

professionals in context, identified with the social, economic, and business environment, with great academic strengths

2. Method

The objective of this study is "To know the main factors that have conditioned the implementation of the Dual Education Model for Undergraduate Level (MEDTecNM) in Technological Institutes of the TecNM and particularly of the Technological Institute of Tijuana according to the perception of the participating teachers/tutors, in order to identify the presence of facilitating elements, barriers and present strategies for their implementation."

To achieve the objective set out in this research, a qualitative research strategy has been used based on knowing the perceptions of the teachers and students participating in the implementation of the MEDTecNM. To achieve this, two sources of information have been used: an initial one using the MED Diagnosis carried out in 2022 by the Secretariat of Extension and Liaison through the Directorate of Academic Liaison of the TecNM, where institutes who have implemented the model were asked to make a SWOT matrix; these acronyms stand for SWOT (Strengths, Weaknesses, Opportunities, Threats); It consists of assessing the strong and weak factors that together diagnose the internal situation of an organization, as well as its external evaluation; that is, the opportunities and threats. It is also a tool that can be considered simple and allows you to get an overview of the strategic situation of a given organization. (Talancón, 2007).

In the second strategy chosen, the design, validation, and application of an electronic questionnaire were carried out, aimed at the teachers/tutors of IT Tijuana who have participated in the MED IT Tijuana from 2014 to 2019 in the careers of Architecture and Civil Engineering in the Department of Earth Sciences. The questionnaire was applied in the January-June 2023 semester to know their opinions about implementing MED IT Tijuana and detecting barriers and facilitators.

2.1. Sample Features

As already mentioned above, the SWOT analysis of the Dual training of the TecNM during the period from 2015 to 2021 applied in the 253 Technological Institutes of the TecNM was used to carry out the Diagnosis of Dual Education carried out by the Secretariat of Extension and Linkage through the Directorate of Liaison and Academic Exchange. Each participating institution was asked to carry out a diagnosis of the situation of the MED through the application of a SWOT matrix with the participating teachers of this model. The results can be found in Table 3. For the application of the questionnaire in IT Tijuana, the sample is made up of 15 professors-tutors of the Department of Earth Sciences of the careers of Architecture and Civil Engineering of IT Tijuana who participated in the MED during the period

2014-2019, in charge of the teaching and academic training of architects and civil engineers. Table 1 shows the Generations of the Dual Education Model of IT Tijuana, and Table 2 the Companies participating in the Dual Education Model program of IT Tijuana.

The questionnaire has been organized into two categories: the profile of the teachers/tutors interviewed, the decision-making process of the implementation of the MED IT Tijuana, and the satisfaction with the implementation of the MED in the ITT, as well as questions about their expectations with this implementation. The posed questions try to be clear, concise, close, and simple. The questionnaire can be found in the annex.

Table 1. Generations of the Dual Education Model of IT Tijuana

Generation	Enterprise	Students		Graduates
		Arch.	C.I.	
I January-December 2014	SEICA	Arch.	5	10
		C.I.	5	
II January-December 2015	SEICA	Arch.	6	10
		C.I.	4	
III Agosto-dic 2015 January-June 2016	CMIC	Arch.	-	5
		C.I.	5	
IV January-December 2016	SEICA	Arch.	8	10
		C.I.	2	
V August-December 2016 January-June 2017	CMIC	Arch.	-	6
		C.I.	6	
YOU January-December 2017	SEICA	Arch.	7	12
		C.I.	5	
VII August-December 2017 January-June 2018	CMIC	Arch.	-	8
		C.I.	8	
VIII January-December 2018	SEICA	Arch.	2	4
		C.I.	2	
IX August-December 2018 January-June 2019	CMIC	Arch.	7	11
		C.I.	4	
X January-December 2019	SEICA	Arch.	2	8
		C.I.	6	
XI August-December 2019 January-June 2020	CMIC	Arch.	8	13
		C.I.	5	
				97

Source: Authors' elaboration 2023

Table 2. Companies participating in the dual education model program

Racing	Architecture	Civil engineering	12 companies
2014-2019		XI Generations	97 graduates
1	SEICA International Group		
2	Crisol Constructora, S.A. de C.V.		
3	Japal Ingeniería, S.A. de C.V.		
4	Libra Ingenieros Civiles, S.A. de C.V.		
5	RJ Ingeniería, S.A. de C.V.		
6	Ingeniería de Bombas y Controles, S.A. de C.V.		
7	Urbanizadora Roma, S.A. de C.V.		
8	Constructora Transpeninsular, S.A. de C.V.		
9	LPM Construcciones, S.A. de C.V.		
10	Grupo Integral de Servicios del Noroeste, S.A. de C.V.		
11	Obra Civil de Baja California, S.A. de C.V.		
12	Gabriel Vizcaino		

Source: Authors' elaboration 2023

2.1.1. Facilitators and Barriers of the MEDTecNM according to the Teachers/Tutors

Based on the SWOT analysis of the TecNM Dual Training carried out by the Secretariat of Extension and Liaison through the Directorate of Liaison and Academic Exchange, it can be analyzed in Table No. 3. It should be noted that teachers/tutors see the following aspects of success: the TecNM has the Dual Education Model, whereas 30% of teachers and principals have been trained at the MEDTecNM; a large percentage of Technological Institutes are interested in implementing the Model; and as a great

opportunity, it has to be that most of the governments of the states of the Republic support the implementation of the MED at a higher level. As for the weaknesses and threats, they are mainly summarized in the fact that some directors and teachers are not yet convinced to implement the MEDTecNM, perhaps because 70% of teachers and directors have not yet been trained in it, as well as the lack of knowledge and unwillingness of companies to participate in the MEDTecNM and the deficient process of linking the Institution with companies.

2.1.2. Analysis of Questionnaires to Professors/Tutors of the Architecture and Civil Engineering Careers 2014-2019

The questionnaire results were designed, validated, and applied to 15 teachers/tutors. The purpose is to know the professional profile of the teachers/tutors, the decision-making process to implement the model and the satisfaction with implementing the MED IT Tijuana. This questionnaire is part of the research in the Doctoral Thesis "Study of the Impact of the Dual Education Model on Graduates of the Architecture and Civil Engineering Careers of the TecNM Technological Institute of Tijuana for their Entry into the Construction and Housing Industry". Six questions were asked about the profile of the interviewees, and 12 questions were asked for teachers/tutors to score between 1 and 5 according to their degree of satisfaction with the implementation of MED IT Tijuana. The 1 corresponds to their lowest score and/or rating, while the 5 expresses their highest score or rating; 14 yes or no questions were asked to complement the information on satisfaction with the implementation of the MED, 6 questions were asked about the expectations of the teachers/tutors about the implementation of the MED IT Tijuana.

Table 3. SWOT analysis

Strengths	To have a dual education model at TecNM.
	In the decree of creation of the TecNM, it is part of the articles of its formation.
	The TECNM has instructed all campuses to implement dual education in all educational programs.
	TecNM teachers and managers have been trained on 30% of the campuses.
	The educational programs that have the greatest influence on DUAL are Computer Systems, Industrial Engineering, and Business Management Engineering.
	Major sectors participating in the Dual are ICT (Software Development) and Agri-Food and Services (Commercialization).
	The operation of the MED on the Campuses is in the Academic Sub directorate, Academic Departments and Division of Studies. (Considering the same areas in the TDs).
	100% of the Campuses are interested in implementing DUAL in their Institutes.
	Work has been done on strategies for implementing the MED on the TECNM Campuses.
	There is a course on dual education at the TECNM designed by the teaching directorate.
Weaknesses	Managers who are not convinced of implementing the MED on their campuses.
	Teachers who are not convinced about implementing the MED in their educational programs.
	Training has NOT been achieved in 70% of principals and teachers.
	Students are afraid to go to companies before finishing their degree.
	Students need to develop soft skills.
Threats	There are no certified teachers, and the teachers of some educational programs do not want to get involved.

Weaknesses	Lack of integration with the productive sector to achieve the competencies of the graduate profile.
	Extraordinary resources are needed to support students and train and pay teachers.
	A specific regulation that strengthens the curricular operation of the modality. Currently, the dual model requires much effort and resources that contrast with the number of students who can participate.
	The pandemic has affected the relationship with companies, which has reduced the opportunities to implement this modality.
	Not all students are interested in participating.
	Companies lack willingness to implement dual education, in addition to the lack of acceptance by companies to invest in the training of young people.
	There is no offer in the industry for a DUAL project, no economic support for the transfer of students, little involvement of teachers, and a lack of a concrete project for each economic unit.
	There is a lack of a recognized figure in the organizational structure to carry out this activity in the different academic departments.
	Lack of willingness on the part of teachers to implement this model in academic programs.
	Companies that express their interest in having dual-education students do not have robust projects that allow them to cover all the speciality subjects that students must cover.
	It is too bureaucratic.
	Understanding and training of the TecNM Dual Education Model for managers and teachers.
	Lack of human resources to increase capacity in the dual program. Lack of organizational structure, training, and/or certification of academic and liaison staff in dual model issues.
	Lack of hours for advising students in Dual Education.
	The process of linking with companies does not work correctly.
	Lack of financial resources on the part of the students to attend the company in person.
Schedule availability for students who work and study.	
There is NO certification of the TECNM's dual SABER Education Model.	
Opportunities	Some companies in Mexico have the Dual Model.
	Some companies accept students, but it has limitations.
	Some state governments support dual education, mainly in the country's centre and north.
	We have the SABER certification of the Dual Education Model for high school.
Threats	Entrepreneurs do not know about the MED.
	Employers consider MED students not as operators but as professionals in training.
	Employers do not consider students suitable for job applications.
	The main problem reported is the lack of companies and their interest in and for the dual education project program.
	There are only a few legally constituted enterprises in the agricultural sector.
	Companies that are not prepared
	Lack of access to industries and/or businesses
	Businesses have closed their doors as a result of the pandemic.
	The company has not implemented the program.
	There are no companies in the region. Only small shops or chain stores such as AURRERA, ELECTRA and COPEL.
	Scarce industrial sector.
	The economic units do not follow up on the activities programmed in the training plan because they sometimes employ students to solve their emerging problems.
	Lack of companies that accept dual students, especially in the careers of Environmental, Electronic and Biomedical Engineering, options are sought in other nearby entities, leading to higher student expenses.
	Some economic units do not have the disposition and personnel to implement Dual, coupled with the distance factor in terms of companies.
	The process of linking with companies does not work properly.
There is a lack of companies in the region that have the capacity and resources to work on this model.	
The regional environment does not favor the model in all careers, especially in the case of local industries, so we work with out-of-state industries virtually.	
Lack of companies that accept the model, related to career profiles, incipient level of companies in the field.	

Source: Secretariat of Extension and Liaison through the Directorate of Outreach and Academic Exchange TecNM 2022

Table 4. Perception of teachers/tutors with the implementation of MED in IT tijuana

Academic Degree	Degree	50%
	Mastery	50%
Teaching experience in years	An average of 18 years of academic experience	
Decision-making process to implement MED in the institution	At the request of the administration	33%
	By decision of the management team	67%
	By consensus of the Academy	0%
	Unknown	0%
What has been your participation in the MED?	Contact with companies	50%
	Training planning	50%
	Advisor/Tutor	83%
	Follow-up visits or evaluations of students	67%
	Other Functions	0%
I would recommend the MED for professional training for the Architecture and Civil Engineering careers.	Yes	No
	100%	0%

Source: Authors' own creation 2023

3. Results and Discussion

According to the answers to the questionnaire to teachers/tutors, the academic degree of the participants is 50%, and 50% of the interviewees have a master's degree. They have an average of 18 years of teaching experience. In the question about who decided to implement the MED in the institution, 33% answered that it was at the administration's request, and 67% of the teachers/tutors

answered that it was the management team's decision. When asked about their participation in the MED, 83% answered that they were tutors; 67% conducted follow-up visits or evaluations to students; 50% participated as a contact with companies; and another 50% were involved in the program's planning. We noticed that when the teachers/tutors asked if they recommend the MED for architecture and civil engineering careers for professional training, 100% said yes.

Table 5. Results of the survey of the degree of satisfaction perceived by teachers/tutors about the graduates of MED IT tijuana

	1 Not at all satisfied	2 Little satisfied	3 Satisfied	4 Pretty much satisfied	5 Totally satisfied	Average
With the quality of in-house training.	1	2	3	4	5	4
	0%	0%	17%	33%	50%	
With the possibility of job placement for graduates.	1	2	3	4	5	5
	0%	0%	0%	0%	100 %	
With the dissemination and information of the MED in the institution	1	2	3	4	5	4
	0%	0%	25%	25%	50%	
With the network of contacts that ITT has with companies	1	2	3	4	5	4.5
	0%	0%	0%	50%	50%	
There is a need to establish links between the institution and the companies.	1	2	3	4	5	4.5
	0%	0%	0%	50%	50%	
With attention to the preparation and qualification in the MED of the teachers/tutors of the institution	1	2	3	4	5	4
	0%	0%	17%	33%	50%	
With the degree of involvement of teachers in MED projects	1	2	3	4	5	4
	0%	0%	17%	33%	50%	
With the consensus between the institution and the company on the content to be taught	1	2	3	4	5	4
	0%	0%	17%	17%	66%	

With the adaptability of the curriculum of the current curriculum to the MED	1	2	3	4	5	4.5
	0%	0%	0%	17%	83%	
Do you consider that the task of the person responsible for coordinating the MED and the advisors is recognized by the educational administration	1	2	3	4	5	3.5
	0%	16%	17%	50%	17%	
Do you think the MED makes better use of and applies the updated technological and procedural tools that the institution does not have and that the company currently has?	1	2	3	4	5	4
	0%	0%	33%	17%	50%	
With the demand and intensity of the program?	1	2	3	4	5	4.5
	0%	0%	0%	33%	67%	

Source: Authors, 2023

Table 6. Results of the survey of the degree of satisfaction perceived by teachers/tutors about the graduates of MED IT tijuana

Do you think that the company's advisor rigorously evaluates MED students?	Yes	83%
	No	17%
Do you think that implementing the MED will generate benefits for the institution?	Yes	100%
	No	0%
Would you like the MED to have greater recognition from the educational administration?	Yes	100%
	No	0%
Do you think the institution's advisors have continuity, or are there changes every semester?	Yes	100%
	No	0%
Do you consider the resources the institution's administration granted sufficient for implementing the MED?	Yes	50%
	No	50%
Does the advisor have time to follow up with the students participating in the MED, i.e., has their academic load been reduced so that they can attend the MED?	Yes	50%
	No	50%
Is it an added workload to participate as a teacher/tutor for teachers?	Yes	33%
	No	67%
Is having MED and traditional students in the same group difficult?	Yes	33%
	No	67%
Are you concerned that the company uses the MED to train its specialists, not professionals?	Yes	50%
	No	50%
The training schedule at the company is adapted to the institution's needs.	Yes	67%
	No	33%
Can this modality function as feedback for the institution in updating study plans and programs?	Yes	100%
	No	0%
Are students motivated to participate in MED?	Yes	100%
	No	0%
Are students satisfied with their participation in the MED?	Yes	100%
	No	0%
Overall, are you satisfied with your participation in the MED?	Yes	100%
	No	0%

Source: Authors' own creation 2023

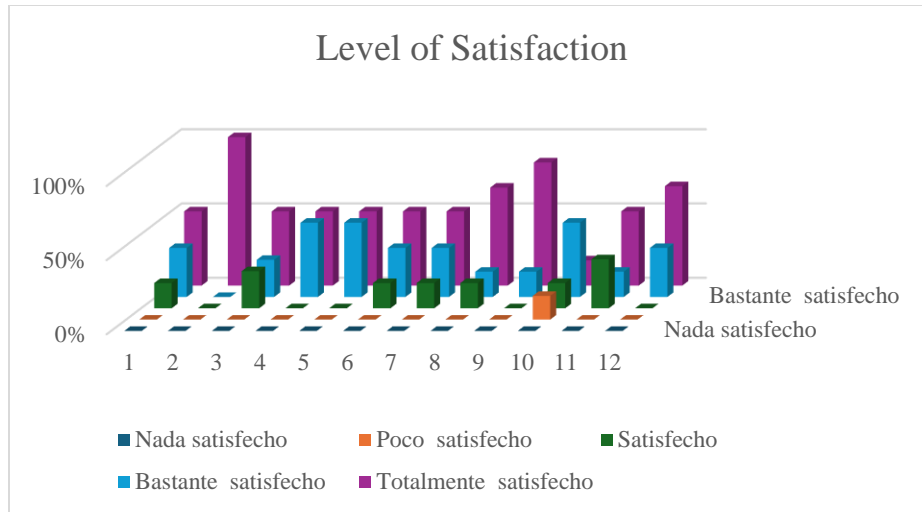


Fig. 1 Level of satisfaction of teachers/tutors with the implementation of MED IT tijuana

Source: Authors, 2023

- Teachers/tutors were asked if they considered that the company's advisor rigorously evaluates MED students, and 83% of respondents answered yes, while 17% of teachers/tutors thought no. Whether they consider that implementing the MED generates benefits in the Institution, 100% of the teachers/tutors answered yes.
- When asked if they would like the MED to have greater recognition from the educational administration, 100% answered yes. They were also asked if they consider that the institution's advisors have continuity or if there are changes every semester, to which they answered yes 100%.
- Regarding whether teachers consider that the resources granted by the institution's administration are sufficient for implementing the MED, 50% consider that they are, and the other 50% do not.
- If the advisor has time to follow up with the students participating in the MED if their academic load has been reduced to attend the MED, the answers were 50% yes and the other 50% no.
- Is it an added workload to participate as a teacher/tutor for teachers? The answer was yes by 33% and no by 67%.
- Is having MED and traditional students in the same group difficult? The answer was yes by 33% and no by 67%.
- Is there a concern that the company uses the IT Tijuana MED to train its specialists and not professionals in the sector: 50% say yes, and the other 50% say no.
- Regarding whether the training schedule at the company is adequate to the institution's needs, 67% of the teachers/tutors answered yes and 33% no. It was also asked if this modality could work as feedback for the institution in updating study plans and programs, and the answers were 100% yes.
- The students were asked if they were motivated to participate in the MED, and the answer was 100% yes. The students were satisfied with their participation in the MED, and the answer was 100% yes.
- Teachers/tutors were asked if they were generally satisfied with their participation in the MED, and the answer was 100% yes.

Table 7. Teachers/tutors' expectations about the implementation of MED IT Tijuana

Do you think that participation in the MED contributes to improving the generic competencies of graduates?	Yes	100%
	No	0%
Do you think that participation in the MED contributes to improving the professional skills of graduates?	Yes	100%
	No	0%
Do you think that students who participate in the MED lose out on the training necessary to complete their professional careers?	Yes	0%
	No	100%
Do you think that participation in the MED promotes the employability of graduates?	Yes	100%
	No	0%
Do you think that participation in the MED improves the image and external projection of the institution?	Yes	100%
	No	0%
Do you think that participation in the MED provides opportunities for participating teachers?	Yes	100%
	No	0%

Source: Authors' own creation 2023

- 100% of the teachers/tutors consider that participation in the MED contributes to improving the generic competencies of graduates.
- 100% of the teachers/tutors consider that participation in the MED contributes to improving graduates' professional skills.
- 100% of the teachers/tutors consider that students who participate in the MED do not lose the training necessary to complete their professional career; also, 100% consider that participation in the MED promotes the employability of graduates; 100% consider that participation in the MED improves the image and external projection of the institution
- 100% of teachers/tutors consider that participation in the MED provides opportunities for participating teachers.

3.1. Main Results of the Questionnaire to Teachers/Tutors

As elements of success, we can conclude that 100% of the teachers/tutors of the Department of Earth Sciences of the careers of Architecture and Civil Engineering would recommend MED IT Tijuana to their students to complement their professional training. The teachers are delighted with the significant possibility of job placement for graduates; they are also totally satisfied with the adaptability of the current curriculum to MED IT Tijuana. A large majority of teachers are satisfied with the program's demands and intensity. As for the satisfaction of the teachers/tutors with the experience, they consider it very positive and are committed to continuity. In the same way, they consider that participation in the MED contributes to improving the generic and specific competencies of graduates. They consider that the implementation of MED IT Tijuana improves the image and external projection of the Institution, providing opportunities for participants and generating benefits for the Institution.

The importance of challenge of implementing and operating the MEDTecNM requires a high degree of coordination and the capacity for dialogue and agreement between the participants: students, institutions and companies. The conviction of being in front of a learning process for all participants should be highlighted. Not only does the student who participates learn, but so do the institution and the companies. In general, the teachers/tutors who have participated in MED IT Tijuana have a positive attitude about its benefits for both the students and the institution. While the results and their potentialities can be seen, some resistance can be found within the institution. The teachers/tutors express that the participation of IT Tijuana in the MED improves the institution's image and projection towards society.

The professors/tutors consider that participation in the MED allows them to update themselves professionally with the possibility of carrying out training in companies; however, they express concern that their participation in the

MED increases their time dedication, valuing it as an added workload, since they have not reduced their academic load, in addition to the fact that they do not receive recognition for their participation. As for the students, the teachers/tutors agree that participation in MED IT Tijuana improves the acquisition of professional skills and favors their labor insertion. Some concerns related to the company's ability to cover the official curriculum program are reported. The teachers/tutors expressed concern that companies get involved in MED IT Tijuana only because of their interest in training their own specialists and because it does not develop the competencies of the Architecture and Civil Engineering sector. Teachers/tutors indicate fear of losing content from the syllabi of the subjects, which they assume will not be worked on in the company for different reasons. It is also observed that, in general, companies at first decide to participate with certain reluctance because they are not very clear about their benefits. However, once they get involved, they want to continue participating.

The positive impact achieved in implementing MED IT Tijuana in the training of Architects and Civil Engineers responds to the need that entrepreneurs and graduates have expressed for so long to have relevant and professional study plans and programs suitable to face the professional field. For the dual system to be successful, it is necessary to contextualize it to know the environment where it will be implemented and the business network surrounding it. The good results obtained by MED IT Tijuana represent a greater commitment for the institution since the quality of education must be a constant that characterizes the institution's educational process and allows a good projection of its graduates. Amongst the limitations found in this study, the few investigations carried out on the MEDTecNM stand out.

4. Conclusion

According to the results of the SWOT analysis applied in 2022 to teachers of Dual training at the TecNM from 2015 to 2021, the survey of the 253 Technological Institutes by the TECNM was taken to carry out the Diagnosis of Dual Education carried out by the Secretariat of Extension and Liaison through the Directorate of Liaison and Academic Exchange, and in particular, results of the implementation in IT Tijuana in the careers of Architecture and Civil Engineering during the period of 2014-2022. It is concluded that dual education is not only a combination of study and work. It is more than a pre-professional practice. The company acquires a particular dimension as a source of academically recognized instruction, developing and integrating students into working life. Then, after having analyzed the results of the SWOT analysis, the bibliographic review of success stories in the MED, national and international, and the questionnaires applied to teachers/tutors of the MED IT Tijuana, it has been possible to reach the following conclusions:

Table 8. Barriers in the implementation of the MED IT Tijuana according to the perception of teachers/tutors

Barriers	
For the Institution	That the training of students at MED IT Tijuana is limited to the specific needs of companies, or that MED is used as a mere selection strategy or a way to obtain cheap labor.
	Successful experiences have not been sufficiently promoted in the country to create an entrepreneurial and institutional culture.
	Difficulty in finding companies willing to participate in MEDTecNM and lack of time to dedicate to it.
	Implementing the MEDTecNM represents an important change in the institution's organisation and the company.
	Generation of excessive bureaucratization.
For Teachers	Participation of teachers voluntarily.
	Conflicts with teachers who did not wish to participate in the MED.
	Teachers' resistance to change.
	The volume of work increases as direct contact with the company is required, as coordination in the follow-up of the student's training.
	The teacher/tutor searches for collaborating companies and explains what MED IT Tijuana consists of and the benefits of participating.
	Selects and monitors the students participating in the MED IT Tijuana.
	Lack of recognition of the work by the administration.
For Students	It cannot be the same for all the academic enrolments that an HEI has because not only the different abilities and competencies influence but also the aspirations of each student.
For Business	There is a lack of information, awareness and enhancement of the benefits of MED IT Tijuana for the company.
	Difficulty finding companies willing to participate in MEDTecNM and lack of time to dedicate to it.

Source: Elaboración propia 2023

Table 9. Facilitators in the implementation of the MED IT Tijuana according to the perception of the teachers/tutors

Facilitators	
For the Institution	The TecNM has a legal framework with guidelines that define the rights and responsibilities of the parties, as well as the governance of the system.
	Participation in the MED gives the institution and the company renown.
	The institution's relationship with companies allows it to know first-hand their needs to update and adapt study plans and programs.
	It expands its educational offer and prestige.
	Its teachers can access facilities, machinery, and new technologies that companies have, but the institution can hardly access them.
For Teachers	They complement their academic knowledge with the day-to-day knowledge of companies.
	It fosters the updating of teachers due to the relationship with companies in the sector.
	Learn about the latest news and trends in companies and transmit them to students in the classroom.
	The possibility of obtaining labor certifications.
	Management of state-of-the-art technologies and equipment in the company.
For Students	The positive impact on students' academic preparation is based on the theory-practice link.
	Learn by doing.
	Job placement opportunities for graduates.
	The acquisition of professional skills and experience.
	Get in touch with the real world of the company and gain professional experience.
	Check-in is practical if what you have been trained for at the Institution fits your profile, interests and skills.
	It increases their motivation.
	Management of state-of-the-art technologies and equipment in the company.
The possibility of obtaining labor certifications.	
They can be paid even if they are students.	

	The students who participate in the MED are a reference for the rest of their classmates.
For Businesses	Meet and train potential employees with good theoretical knowledge and a desire to apply it in practice, and who, in addition, bring "freshness" and new ways of doing things to the company and can be the generational change that guarantees the company's future.
	It promotes its social responsibility by becoming a training company, transmits an image of dynamism, modernity and commitment to society, and can gain a presence in the media and thus increase its visibility.

Source: Authors' own elaboration 2023

Table 10. Strategies in the implementation of the MED IT Tijuana according to the perception of the teachers/tutors

Strategies	
For the Institution	Tailoring of study plans and programs to the needs of the professional field.
	To keep the study plans and programs up to date based on the needs of the business environment, keeping them constantly in force.
	The approach provided by the MED enriches the linking processes.
	The parties involved, students, HEIs, and companies, must be flexible for the MED to function.
	It is important to soften the demands and the effort it entails for students and to adapt schedules and conditions.
	A standardization of formats is required to allow the process to generate tangible evidence.
	Establish agile management models to reduce bureaucratization, integrating ICTs into all processes.
	Implement a well-controlled network of communication between the institution and the company.
	Simultaneously, we offer the traditional plan and the MEDTecNM in the HEIs.
	Promote updating and continuous training processes for the training of participating teachers.
	Generate a policy of promotion and understanding of the MEDTecNM within the companies of the sector.
	Establish collaboration agreements with companies for the development of the MEDTecNM.
	Carry out the necessary legal considerations to guarantee the medical safety of students, including occupational hazards.
	Establish recognition mechanisms and incentives for academic and administrative staff and participating companies.
To share and socialize the success stories of MED IT Tijuana among professionals, companies and schools.	
For Teachers	Evolve the teacher's performance to adapt to the MEDTecNM.
	Visit companies to inform them about MED IT Tijuana and distribute the training plan.
	Promote and provide information about the MED to the seventh and eighth-semester groups.
	Offer the portfolio-building course to students aspiring to participate in the model.
	Make a preliminary selection and present the candidates who best fit their characteristics to the company.
	Ensure that the necessary documentation has been complied with.
	Maintain continuous contact with the company's tutor and the students to maintain a correct follow-up of their training.
	Evaluate the students considering the assessment of the company's tutor.
	The model's success is based on the strict monitoring and control of compliance with the guidelines of the MEDTecNM to guarantee the quality of the student's training.
	It is necessary to raise awareness and sensitize companies, the educational community, and society about a change of approach in vocational training.
For Students	From the first semester, students should be informed of the existence of MED IT Tijuana (requirements, training time, regulations, guidelines, among others), including company visits.
	Days of exchange of experiences between students who have already completed the MED IT Tijuana.
	Creation of informational materials that can be disseminated through social networks

	transmitting information about the MED. Student Guide.
	The graduates of MED IT Tijuana become a direct link with the new generations of participants.
	Attend promptly to the theoretical and practical hours defined within the MED IT Tijuana in which he/she participates.
	Follow up and attend to the evaluation processes established by the institution and the company.
	Periodically submit reports on the progress of practical training in the company.
For Businesses	The companies participating in MED IT Tijuana receive some recognition.
	To give visibility and credibility to the companies participating in the MED IT Tijuana as a learning scenario.
	Contribute to the creation and/or updating of study programs.
	Comply at all times with the contents established within the MED IT Tijuana training plan.
	Carry out the academic procedures and requirements for obtaining your professional degree.

Source: Authors' own elaboration 2023

Proposals for Improvement

1. Offer teachers/tutors the necessary resources and support so they feel their work is more recognized and valued and can overcome some of the perceived difficulties and resistance.
2. If the MEDTecNM is to be implemented in the institution, teachers must be trained in the model to break with the erroneous perceptions about its quality.
3. The model's success is based on the strict monitoring and control of compliance with the guidelines of the

MEDTecNM to guarantee the quality of the student's training.

This work can be the starting point for further research on the company as a training institution in the MEDTecNM and on the tasks and functions performed by the company's tutors. In addition, it would be interesting to know in future works the development of the MED in companies of different sizes and productive sectors to compare the implementation and development processes of dual education.

References

[1] Geoffrey Boulton, and Colin Lucas, "What are Universities for?," *Chinese Science Bulletin*, vol. 56, pp. 2506-2517, 2011. [[CrossRef](#)] [[Google Scholar](#)] [[Publisher Link](#)]

[2] Lorenzo Compagnucci, and Francesca Spigarelli, "The Third Mission of the University: A Systematic Literature Review on Potentials and Constraints," *Technological Forecasting and Social Change*, vol. 161, pp. 1-30, 2020. [[CrossRef](#)] [[Google Scholar](#)] [[Publisher Link](#)]

[3] Unesco, "World Declaration on Higher Education in the 21st Century, Vision and Action," *Journal of Higher Education and Society (ESS)*, vol. 9, no. 2, pp. 97-113, 1998. [[Google Scholar](#)] [[Publisher Link](#)]

[4] Eugenia M. Villalobos-González, "Social Construction in Architectural Practice: A Critical Review," *Context Magazine of the Faculty of Architecture of the Autonomous University of Nuevo León*, vol. 14, no. 20, pp. 99-113, 2020. [[CrossRef](#)] [[Google Scholar](#)] [[Publisher Link](#)]

[5] "Dual Education Model for Undergraduate Level National Technology of Mexico," Secretary of Public Education, pp. 1-201, 2015. [[Publisher Link](#)]

[6] Ramiro P. Carvajal, Ariel J. Romero, and Gustavo Alvarez, "Strategy to Contribute to the Implementation of Dual Training for Business Sciences Professionals in Small and Medium Enterprises in the Province of Tungurahua, Ecuador," *University Education*, vol. 10, no. 5, pp. 29-41, 2017. [[CrossRef](#)] [[Google Scholar](#)] [[Publisher Link](#)]

[7] Buddhini Ginigaddara, Thayaparan Gajendran, and Cameron Beard, "A Critical Review of Quantity Surveying Education in an Offsite Construction Perspective: Strategies for Up-Skilling," *Construction Innovation*, 2022. [[CrossRef](#)] [[Google Scholar](#)] [[Publisher Link](#)]

[8] Espinoza Freire, E. Dual Training In Ecuador, Challenges For Higher Education And Business," *Osteoarthritis and Cartilage*, vol. 12, no. 3, pp. 304-311, 2020. [[Google Scholar](#)] [[Publisher Link](#)]

[9] Josselyn Paulina Pico-Poma, and Leticia Azucena Vaca-Cárdenas, "Flipped Classroom in Teaching-Learning Processes in Engineering Courses: Systematic Review," *Electronic Journal of Education Sciences, Humanities, Arts and Fine Arts*, vol. 6, no. 12, pp. 61-102, 2023. [[CrossRef](#)] [[Google Scholar](#)] [[Publisher Link](#)]

[10] Oscar Ignacio Hernández-Hernández, "Knowledge Management and Design: An alternative for curricular change in the Architecture program at the National Institute of Technology of Mexico," *Journal of Interdisciplinary Studies of Art, Design and Culture*, no. 9, pp. 11-35, 2023. [[Google Scholar](#)] [[Publisher Link](#)]

- [11] Flores Sánchez, and Gustavo Geovanni, “Impact of Dual Training on the Labour Market: The Case of Business Engineering at the University of Cuenca,” *National University of the South*, pp. 1-211, 2019. [[Google Scholar](#)] [[Publisher Link](#)]
- [12] Baymurova Nigora Rakhimovna, “Integration of Theory and Practice of the Dual Education System in the Field of Light Industry Education,” *European International Journal of Multidisciplinary Research and Management Studies*, vol. 4, no. 2, pp. 336-341, 2024. [[Google Scholar](#)] [[Publisher Link](#)]