POLITECNICO
MILANO 1863

School Of Urbanistic Architecture and Construction Engineering

Master of Science degree in **Management of Built Environment**

'Elements that promote interdisciplinarity in higher education environments and campuses'

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29.04.2020 - Spring Term

Acknowledgement

First of all, I would like to thank my co-supervisor Chiara, who always managed to find opportunity to guide me with a constructive approach to improve the academic value of this work. I deeply appreciate the support she showed at every challenging step of writing my thesis paper. I am also grateful to Prof. Ciaramella, who is the first person ever to introduce me into this field of study during my studentship at Politecnico, for taking time to contribute to this process with his valuable advisory.

I would like to specify and acknowledge Aalto University and my dear mentors there for having me inspired to dare covering such a complex subject in my master's thesis. I am fully aware that one semester I spent in Finland in an environment that was drastically different from where I was before had an immense impact on my way of thinking. It has been a marathon for me, literally.

My dear family back in Istanbul, you are the biggest treasure I have and will always be so. You taught me to hold firm and appreciative whatever comes my way in life, to constantly improve myself as an individual, and most importantly to stay true to my values and cheer up regardless of the challenges. Sizleri çok seviyorum, iyi ki varsınız ve hep yanımdasınız. Paşa, Belgin ve diğer güzellerim! Sizler de bana ne zaman 'gücüm kalmadı' dediysem masumiyetinizle hep bir umut, bir enerji kaynağı oldunuz.

Y dedico la ultima palabra a una persona muy especial para mí. Te agradezco mucho desde el fondo de mi corazón que has sido siempre a mi lado aunque no fuera tan agradable. Me mostraste una y otra vez que cada uno tenga su camino único y personal, que hay que simplemente vivir sin volver a pesar las consecuencias. Gracias por tu apoyo infinito y aguantar la buena y la mala en conjunto.

Abstract

The higher education setting has been going through a substantial evolution, as the boundaries of spaces and systems that are allocated for a single function dissolve to favour flexibility. This process has been accelerated by transitioning of contemporary education methods and learner's altering interests in how an environment should complement the knowledge acquisition. Besides, global changes in social norms, technological and civil development reshape the interaction of beings and administrative processes.

As the frontiers of science and creativity lie at the intersection of disciplines -at interdisciplinary systems, higher education institutes are expected to provide their community with a fully-comprehensive educational experience within environments of favorable cross-disciplinarity. Numerous research has been conducted on this topic, and sufficient theoretical knowledge is available for handling the complex and multidimensional organization of higher education environments. Although, there is a gap between the statement of what is not working and the actualization upon these findings. This work attempts to outline the possible most influential success indicators in determining a brief set of elements towards interdisciplinarity during the evolution of university campuses.

In addition, the multidimensional nature of human learning requires a highly elaborated treatment. However, there is a lack of available compilation of accountable guidelines that propose an action plan to execute throughout this above-mentioned metamorphosis in tertiary education.

Through this thesis work, a tentative was made to understand first the problem complexity and challenges throughout a literature review. The second and third stages were elaborated to explore various possible ways through a multiple case study and comparison tables to represent the elements in a several criteria that cultivate achievement in interdisciplinary higher education environments.

Finally, a whole synthesis from the multitude of these criteria was summarized in a few points, suggesting a compact framework of highly critical indicators. To conclude, the findings from the comparison and discussion were highlighted. Within its limitations of case selection and indicators defined in divergent themes, this research proposes a multi-disciplinary and simple approach of a framework, which can be used as a basis for universities for creating a custom-fit scheme to support their very own evolution process.

Keywords
Interdisciplinarity in Campuses, Higher Education, Interdisciplinary Learning Environments

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SECTION 1: Literature review

1. Introduction

A rapid and global change in societal values and economic structure took place in the 21st century. Over time, an accelerated digitalization dominated in many industries, even in those that were considered not essentially leveraging technological developments. This unexpected take-over of high technology tools induced an increasing insufficiency of trained employees as required in the age of modernization. Although, the gap between people and opportunities has reduced thanks to international mobility, as globalization has been widely acknowledged as another big phenomena particular to this century. In addition to the progressive information flow, the mobility of capital, services, and brainpower have followed.

With a growing request for capabilities beyond stereotypical hard-skills, people with multidisciplinary skills gained surprisingly high advantages in employment over those that achieved better average grades back in college. It proves that a unidimensional education path provided by higher education institutes fell behind the progressive demands of the time. The current curricular program nor the policies applied in higher education institutes have not been able to catch up with the transition in the economy, which has also been constantly reshaping the career options and human behaviours. Creative solution-oriented ideas now outweigh the accountability of graduation diplomas. There is a straightforward explanation to the current circumstances: the breakdown of barriers to access information, combined with expanded opportunities both on a personal level, and supplementary soft skills such as problem-solving and leadership.

The recent global interconnectedness prompted disciplinary fields to amalgamate and suggest alternative interdisciplinary domains. New subject areas have been invented which thrive at the junction of diverse areas of inquiry. As a result, the conventional mono-disciplinarity of educational programs employed by the advanced education institutes failed fulfilling the changing expectations. The capacity of putting the theory into practice, the ability to take initiatives and team-work skills quickly became top competences, especially in an environment that brings different backgrounds and together. This situation brought up introductiory initiatives by relevant authorities for a smoother evolution process of tertiary education. That's where the appropriate design, planning and assessment of interdisciplinary learning environments on campuses come into play. Still, according to international surveys conducted by official entities, many countries cannot take pace with these progressive developments. By strategically allocated resources and collaborative activities a better success rate must be achieved on global trends, as indicated in many EU competitiveness reports (OECD, 2017). On the other hand, it is not an easy job introducing 'rule-breaker' implementations into a customary set of cultural habits and traditional values. An awareness regarding interdisciplinary thinking in higher education environments should be created across different stakeholders to spread it out in the community. Providing people with cross-

disciplinary environments that support learning activities can be an effective way of enhancing their relationship with the changing societal and economical structure.

Nowadays, universities promise an intermediary education path from more generic to exclusively specialized, so they have to host a variety of facility spaces ready to satisfy different purposes. Therefore, the evolution of tertiary education spaces and generation of alternative venues has brought up many fundamental social and technical aspects (Bennett, 2007; Tapio, Kohl, Tikkanen, & Salonen, 2011) such as the perception of hierarchical structure (Imms, Cleveland & Fisher, 2016), the combination of changing trends in the social life that also manifested itself in the tertiary education space planning (Coulson, Roberts & Taylor, 2014), definition of disciplinary boundaries (Gouvea, Sawtelle, Geller & Turpen, 2013) and the activity types on the spectrum of leisure at one end and pure labor at another (Neuman et al., 2013).

In relation to this statement, the purpose of this paper is to suggest answers to questions that are frequently raised in educational context concerning interdisciplinary and cross-boundary learning environments, although widely left unanswered. Which elements do predominantly favor the satisfaction of users in such environments? What are the contemporary requirements within spaces of education that render them feasible and sustainable throughout the following decades? How well have the real user needs been discerned when immediate functions of a place are given due consideration? On the other hand; are there any spatial organization patterns that repeat across the globe in higher education facilities for institutional welfare? Could it be possible to portray an integral scheme of principles that might be followed by design teams working on learning-and-teaching-related settings?

1.2. Problem Statement and Objective
The results obtained from this inquiry are expected to address a useful insight into which elements make modern learning environments adapt to the present economic and societal changes through interdisciplinarity. The research investigated the possibly most influential factors in cultivating interdisciplinary and multifunctional physical and virtual spaces on university campuses, which also promote modes of interacting among different beneficiaries, from students to staff or external collaboratives. As suggested by the findings on Table2-2, flexibility, collaboration and digitization first and foremost, appear to be the foundation of establishing exemplary and functional learning environments efficiently implementing interdisciplinary principles (Temple, 2008; Ehmann et al., 2012; Imms et al., 2016; Coulson et al., 2014; Haggans, 2015). To validate social and rather informal needs of campus users, there are campus areas dedicated to leisure activities, study breaks for socializing with friends and re-energizing oneself by enjoying proper catering services (Acker & Miller, 2005; Ehmann et al., 2012; Ibrahim & Fadzil, 2013). To conclude, many components become a determinant in the ultimate accomplishment of great educational places that feel the pulse of most recent updates, rather than a single factor being the biggest influence. In

return to the diversity of problematic statements, the transformation of places that host learning and research activities are examined based on various aspects:

1. The changing immediate characteristics of contemporary learning spaces, such as personalization and interdisciplinarity in educational institutes as a popular theme.

2. The significance of the sense of community in collaborative and motivating campus culture.

3. The reforms implemented to match present user needs, and the principles that imply success in the process of organizational change.

4. The impact of facility management as an interdisciplinary field in restoring contemporary learning environments for improved efficiency and optimization of the.

5. The methods to support these places to adapt or extend considering instant or longstanding needs.

6. The guidelines to assure a better approach in the performance and quality assessment of such facilities, at varying stages during property lifetime.

In realization to the complexity of the possible impact factors, the problem statement culminated in its latest form as in the following:

> *''Elements that promote interdisciplinarity in higher education environments and campuses''*

1.3. Methodology

This paper is composed of three main sections, and aims at providing a set of feasible suggestions of application of interdisciplinarity in educational environments. The first section delivers information from the literature review, which in total covers resources published from 1973 until present day, mostly including research papers as well as organization reports, independent publishings and blog posts. Therefore, the prevalent data is qualitative, except for occasional statistical figures. The revision of trends in educational facilities provided a rich insight towards the interdisciplinary evaluation of determinants, considering the multiplicity of factors that were defined as influential in this topic. The content extends from methods of facility management practice, technological applications to monitor the response, to social and behavioral sciences. The second section exhibits a case study, with the information gathered from the textual resources in access. In order to gain an in-depth understanding of how modern interdisciplinary facilities are structured, the highlighted components of each specific context, as well as the diversified visions of each organization

existing behind these attempts of modernization, were scrutinized in table subdivisions. These are outstanding institutes in terms of innovative regulations and incorporation of interdisciplinary methods, as required by this century. The material conveyed the ideas, overall themes, and experiences in each unique case. In connection with the paper's theme, the resources occasionally befell in multidisciplinary areas. The pedagogical methods and science of teaching were constantly repetitive subjects in the reference list. As a more technical approach, quality assurance of built assets proposed principles to properly evaluate the physical capacity of a built environment of educational activities. Beyond those, the materials that suggested a re-evaluation of campus culture and active student engagement in order to create a medium that would enrich the experience of skill acquisition were involved as valuable aspects to benefit from. Finally, the third section recaps the presented arguments and own findings throughout the study, showcased on a final summary of findings on Table 3-1.

The process was executed in this structure, with a projection that research publications would provide a collective basis for analyzing the selected cases and their comparison. The foundation of this research is built on different but, in fact, relatable aspects of study fields. These statements would constitute a justification in the process of case analysis, with respect to the outstanding characteristics of each project, that is realized across labels in tables In consequence, the literary information and case study section would be in a strong reciprocal reference which collaborates with the objective of achieving a set of proposed standards upon the development of interdisciplinary learning environments and collaboration-oriented campuses.

2. Brief history of Higher Education Campuses

The term campus originates in Greek idiom, meaning *green*, and also *communal designed topography*. In the successive times of the Roman Empire, the term evolves into *methodically organized soldierly campgrounds* (Neuman et al., 2013). Ever since, the campus context has been a presentation of this ancient contradiction. The campus today appears as a crucial base for tertiary education experience, particularly when considered to which extent digitization and disciplinary amalgamation have dominated the way of operating the productive activities of modern human (Neuman, Fellow of the American Institute of Architects [FAIA] & Leadership in Energy and Environmental Design Professional Exams [LEED AP], 2013).

The system of higher education and the campus culture, in esence, have their origins in medieval Europe. Throughout history, diverse cultures around the world founded a variety of higher-learning institutions to effectuate educational activities. They arose as environments where students and teachers shared a secluded habitat to live and work side by side. These ancient centers were subsidized and supervised by rulers; by religious organizations such as monastic schools, and madrasas; by scientific societies, for instance, observatories (Community, 2020). Although, the constitutional terms of today's higher education around the world trace back to the model countries such as France, Germany, and Great Britain. Later, America followed this scholastic concept, the idea of the campus setting, which preceded from early examples of educational institutes on the UK's secondary and tertiary schooling model. However, the original campus model evolved from the secluded ancient European type to a diverse set of independent styles, developed particularly in Anglo-saxon cultures –in the US and the UK . Early examples of colleges were all built-in exclusively individual buildings -Princeton University campus- or established like a sanctuary of functional divisions that exhibits typical American values -the infamous Harvard University (Corbett, 2003). In terms of physical presence, the US campuses are briefly distinguished for the following three chief arguments:

1. Student accommodation within campus territory is treated as a priority component.

2. The university is perceived as an intimate and cloistered establishment.

3. Sports units hold supremacy in universities' fame and recognition when compared to European peers. To sum up, American universities uniquely manifest *the total integration of athletic, commercial, and academic interests* (Baker & Smith, 1990; Gumprecht, 2008).

Contradicting with the prior statements, antique European academies had open-plan territories, blended in nearby civil settlements that favored a free flow of knowledge. The city was seen as raw material for study by a newly professional class; these professionals reciprocated by creating a metropolitan culture based on *rationality, expertise, training, and authority* (Haar, 2011, p.41). However fast forward, the movement of ''mass higher education'' progressed in the early 1960s, which proceeded from the Europe-wide elaboration of modernist urban planning and the territorial proliferation of universities subsequent to World War II (WWII). Whether the campus is urban or rural, isolated from or blended in its environment, nevertheless does not correlate to its historical value neither success measures.

Haar (2011) further explains that to favour the student on the ground rather than the inanimate urban drawings, colloquial spaces embedded in and around classrooms, and a successful outdoor space for informal meet-ups, which was in its time considered even utopian. At last the author points out, *''…particular architectural forms could produce particular human responses, societies, interactions, and communities''* (p. 140–141). Consecutively, cross-disciplinary dialoges have been discussed within the theme of campus planning, which has led up to the space recreation and innovation for higher education (Yanni, 2012).

With the turn of the 21st century, universities have been considered the principal social hub for learning activities. The essential arrangements of how universities generate and distribute knowledge and evaluate students have remained untouched through societal changes shaped by technology—the Industrial Revolution, the telephone, television, and computers. Today, however, the higher education industry seems responsive to tech disruption as much as other information-centric industries do. The delivery of knowledge is not bound to a school campus anymore. The technological convenience of cloud-based storage, mobile connectivity, and limitless accessibility of information have stacked an enormous size of knowledge in the Web. Consequently, an intensive inspection of the modern university's purpose and its role within a well-structured society has been stimulated (Bledstein, 1976). For instance, contemporary higher education includes many sorts, from postsecondary specialization and research to various professional schools in fields such as law, medicine, business, music, and art. Similar establishments such as vocational training schools, junior colleges, and institutes of technology count in as well. The Coventry University in the UK, nonetheless having a deep-rooted history in country's past, stated an endeavour to pioneer new possibilities learning through supportive and social facilities. The introduction of the project 'The Hub' in the university campus established a centre of student life, which was planned and executed to engender a multi-purpose venue.

Figure 2-1. Bright yellow furnishings and study booths are complete with power and large flat-screens with laptops: The Hub of Coventry University (Parafianowicz, 2011)

Different resources advocate for a few foundational features of today's great higher education organizations:

1. Curricular and physical perfection of education.
2. Research and evelopment (R&D) facilities and distribution of knowledge.
3. Extra-curricular activities for community life.
4. Relationship management among institutional actors (Levin, 2006; Altbach, 2011).

2.1. The role of higher education institutes in the society

The rise of a middle class in the population induced the professional identity to rank the top priority. And the policy was developed, which stipulated the personal value based on earned credits. Since then, this perspective have filtered in modern person's consciousness and the competent profile of one has been defined by the merit-based education system as it is today (Bledstein, 1976). Even so, the campus culture enabled its members to dedicate themselves to many leisure activities. These entailed the emergence of various student unions arising from the certain awareness of global issues or national conflicts, which aspires

to represent self-reliant voices within the institutional community. Higher education institutions have generally recognized autonomous movements and common activities of arts and science without impediments. Likewise, cross-disciplinary ventures beyond single-disciplinary commitments have been promoted with granted supply and room. In view of this fact, diverse intellectual groups procured public acceptance, and they have stood up for the rights they believe in, which certainly benefits the larger community.

From the 1960s onward, students commenced protesting the expansion of campus territory, arguing that graduate-level education was rather transforming into a profit-oriented market, while remissing adequate improvements demanded by students. Coupled with the intense increase in matriculation at tertiary education institutes solely in 10 years until 1970, from 3.6 to 8.5 million people, just in the USA. This impromptu population in campuses catalyzed the protests more, referring to the unique university identities being substituted for standardized lecturing for the overcrowding. Personalized activities and students' supervisory engagement in the campus culture was being discarded. The curricular programs were not in compliance with students' evolving needs any longer, nor satisfying the community shortfall (Broadhurst, 2014). However, the instituted curricula of strict lecture hours is being discarded. As of now, present tertiary education suggests a student-centered program structure that can broaden the options and enable individualized paths leading to proficient learning. Besides, the merit-based education system, which is founded on the principle of rewarding ability and talent, exemplifies a domain that connects the state, the market and the individual benefits more than any other association formed around the shared ideas. Universities also substantiate a behavioral model for the welfare of public society, which is a direct contributing factor to a country's economic competitiveness, productive force, and qualities that determine a prosperous stance in the global arena (Jalaliyoon & Taherdoost, 2012).

The physical existence of universities is now in question for increasing student absenteeism and online accessibility of knowledge to everyone who desires (Wilson & Cotgrave, 2016). From an economic perspective, university buildings are and will be increasingly underused as physical facilities for the anticipated and traditional purposes according to OECD 2011 reports. Still, the physical and material learning environments are stipulated to exist in the long future despite the steadily progressing communicative technologies, as the real in-person connection will remain irreplaceable (Neuman, FAIA & LEED AP, 2013). One focal subject of interest on campus evolution is predicted to be interdisciplinarity in educational environments. The newborn industry fields and global issues, that are mostly involved in cross-disciplinary interfaces, entail the development of corporate and academy unions for common welfare as fundamental. Recreation amenities and business incubator centers will be involved in this stream too. Therefore, spatial planning is a critical factor to promote

either isolated disciplinary fields or cross disciplines engagement instead. In the wake of changing trends, there is an inclination towards giving priority to the following elements of planning in higher education; physical setting, accessibility, and effective arrangement. All these aspects stand out as uppermost concerns since university remains physically present; although facing rapid, and sometimes radical visionary adaptation requirements (Coulson et al., 2014).

2.2. Future expectations

The higher education sector anticipates taking a powerful step: innovative pedagogical approaches will be more widely employed. Commercial finance will still be spurring the innovative decisions in high technology products in the near future. Rather than formal long-stood teaching formats, peer-to-peer learning and education through interdisciplinary collaboration will dominate the higher education scene. Yet solidly set accreditation system raises organizational boundaries in opposition to individually tailored degree schemes (Bledstein, 1976).

The efforts for quality refreshment and student engagement in on-campus activities have undergone recent acceleration (Wilson & Cotgrave, 2016). Ambitious construction investments will be relented and the key functions will be revised in terms of method and priorities (Rytkönen, Nenonen, Österlund, & Kojo, 2015). The major function of the university campus has been subject to a change as it is now considered an intersection facility of encounters, enabling collaborative project works and group tasks from a student viewpoint. For this reason, multidisciplinary learning environments should intensely engage in innovative proposals and knowledge transferring methods in design and planning (Rytkönen, Heywood, & Nenonen, 2017).

The internationalization process in higher education institutions, as one of the steadily encountered elements in academic life, demonstrates that extended duration of incremental change tends to succeed. On the contrary, cases that press deep change and externally driven efforts are more likely to fail. In the past, educational organizations displayed an inactive and restrained disposition imposed by the robust norms and especially by traditions which isolated them from the major reforms that took effect in other sectors. Recently, the situation has been transitioning across all sections of education. In spite of the concerns of the decision-makers upon legitimacy about change management, the present theories of organizational change advise a way of investigating the major institutional transformation. It was analyzed into two overlapping stages: while maintaining the operational stability, periodical and instant introduction of profound change is being accentuated. As long as that conforms with the organization's root elements, success is attainable (Parsons & Fidler, 2005).

As Parsons and Fidler (2005) suggests, throughout the period of incremental reforms, the base structure remains unchanged which is composed of the following elements:

1. Essential values and beliefs.
2. The fundamental strategy of the institute.
3. Power structure.
4. Managerial structure.
5. Control policies.

2.3. Administrative and curricular status

The autonomy of higher educational institutions is strikingly pronounced in Great Britain. Its universities benefit from almost absolute autonomy in their administration and the determination of their curricula, even though being fully funded from the state. In British universities, academic programs are more highly specialized than their European peers. Students have to deal with a more complicated examination process to obtain better chances of entering the university of their choice. The centralized admissions board cooperates with the close supervision of students through a tutorial system while selecting the candidates.

The United States deviates from its counterparts in Europe in specific ways. Universities are either privately funded foundations or are public establishments that financially depend on the government. In the US, there is a national premise that students should follow at least two years of university education after completion of secondary school. Therefore, "junior colleges" and "community colleges" have formed to provide that, in contrast to the traditional universities and colleges which are dedicated to four years of study for a degree. The first two years of a student's studies comprise of prescribed courses in a broad range of subject areas. In the following years of study, the student specializes in a subject field. Another distinct feature from the European model is that students are assessed according to their performance in individual courses, where discussion and reasoning count crucial (Higher Education, 1998).

An adequate example of all-favoring administration can be the Finnish approach that exemplifies equal distribution of opportunities across its participants **(Table 2-1)**. The government funding provides everyone with affordable education while maintaining the standardized quality, furthermore, a decentralized organisation allows local decision-making. Fair allocation of resources established a ground of trust and respect instead of a competitive climate among all actors that are publicly funded. Sà (2008) asserts as well, that funding plays an important role in today's academy for conducting interdisciplinary and cross-specialty studies. Besides, reforms regulated the former strategy of dividing students across different specialization paths, and instead developed a shared curricular program to

even up the chances for in an all-rounded learning environment. It was stated that Finland relied on its internal sources for innovative production and soft-skills development in humans, on the contrary of the global standards. This implementation over the long term, brought independence combined with participative learning methods. Eventually, creativity and innovative spirit paved the core of an education system that recognized the societal needs and values (Darling-Hammond, 2009).

Table 2-1: Worlwide education trends versus exemplary and pioneerin Finnish policies of reform in education (Darling-Hammond, 2009).

Regulations and revolving values in education policy	
Worldwide trends	**Set of policies applied in Finland**
Institutionalization: making uniform and stereotypical rules of evaluation and educational activity planning, on the assumption of a globally consented list of standards would work for all differentiated institutes.	**Adjustable models and roughly prescribed codes:** innovative and up-to date organization of scholar programs, supporting learning modes and allowing students to create their own educational program in a liberated way.
Limited proficiency in elementary subjects: main goal being a shallow knowledge acquisition in basic subjects.	**All-embracing approach nurtured with creative initiative:** Personal improvement and skills acquisition in different prospects, a profound level of knowledge gain.
Simple predictivity of system consequences: the primary determinant of successful learners remains the grades of the same test applied to every individual, despite the serious differences in learning styles and characters.	**Smart system of evaluation of the education and trust in the expertise:** Fair and wise approach to student's assessment in terms of achievement, individually considerate evaluation of everyone and corresponding feedbacks from instructors.

3. Modern Pedagogy and Educational Spaces

The ways human interaction happens, knowledge creation, working and learning have been evidently transforming (Rytkönen, 2016). The course of global trends have the determining role in educational ecosystem by the influence of industries running on knowledge-based activities (Live Baltic Campus, n.d.). Consequently, new ways of learning were sought, which would consciously occupy with the new-world problems, such as protection of natural resources and societal well-being. This revolution has to be a holistic approach within transdisciplinarity, systems thinking, and long-term thinking. Besides, significant findings in cognitive sciences kept verifiying the effectivity of teaching methods in the learning process that involved active student engagement, confuting the deception that assumes students passive recipients of knowledge. The same studies affirmed as well that student preferences and learning styles diversify, whereas peer-interaction and hands-on application were effective ways to reinforce cognitive learning. Further explorations on cognitive principles of the brain propagated experiential teaching and learning methods in higher education pedagogy, sided with recently recognized conceptions of collaboration, team-learning, role-playing and simulative problem-based learning. The amalgamation of these discoveries eventually embodied multidisciplinary perspectives and interdisciplinary integration in educational environments. Thus, complex problems that reshaped the academic learning had to operate through interdisciplinary methods of problem-solving and genuine approach towards them (Frodeman, Thompson & Mitcham, 2010, p.375). Concordantly, a twofold distinction of contemporary problems was elaborated in the 1970s: 1) Determinate problems, exhibiting a linear process of design from problem definition to problem solution; and 2) Indeterminate complex problems which have no single "correct" answer, and whose solutions are iterative and open-ended. The latter type of problems tend to exemplify higher order problems with complexity of nonlinear dynamics and thresholds. From here onward, the term design thinking has developed, which offered the researchers and learners collaborative intellectual exploration. Concepts of complex systems thinking, social psychology and group dynamics emerged free from the conventional disciplinary anchorage. Design Thinking in educational domains currently evolves in two different approaches:

1. Whole System: group dynamics and building interdisciplinary collaboration, which adopt a complex systems perspective with a focus on finding solutions to broader challenges, like climate change or poverty.
2. Design Labs: prototyping and -typically technological- innovation, focus rather on product or service design, and user experience. A recent case that suitably fits to the given definition is Aalto University Design Factory, which is a platform for co-creation across disciplinary, organisational and even geographical boundaries. Born in Aalto University, a network of over 20 Design Factories across the globe develops creative ways of working, spatial solutions and enhanced interdisciplinary interaction to support world-class product design in educational, research and practical application contexts (Design Factory, 2018).

3.1. New learning methods for interdisciplinarity

The higher education sector manifests two general principles concerning interdisciplinary education according to the literature sources. First, institutes that are founded and operating intentionally to provide interdisciplinary instruction on an organization-wide scale. Second, learning and research activities that are held by conventionally specialty-oriented departments of an education institute. The second condition should incite usually more investigation for establishing an interdisciplinary culture of the academic system for having a typical structure of dispersed disciplinary units (Lindvig, Lyall & Meagher, 2019).

The arrival of the 21st century led a group of psychoanalysts and pedagogy experts to initiate a revision of the long-standing educational program. According to the proposition, through experiential engagement and firsthand practice one attains deep knowledge, for which the information taught in lectures is further processed in student's mind. This finding may suggest a shift toward liberated scheduling of learning activities accustomed to individual interests and preference, opposing long-standing learning scheme's rigid composition and teacher-oriented academic structure. Nevertheless, the teacher consequently resolves into an encouraging agent to help students discovering the ways they learn the best and perform most efficiently in a reflective context. This way, learners reclaim their productive participation and accountability through diverse tasks. ("Constructivism and student centered learning", 2019). Damşa and Lange (2019) additionally address that student-centred learning (SCL) aspires to reach a profound degree of knowledge in many regards with supplementary exercises. The complex nature of learning process has for long been perceived a legitimate consequence, but the act of learning encompasses a path of discovery through serendipitous steps where ambiental performance have a strong influence. Progressive Education (2019) testifies that learning reinforces by performing the practical sessions of knowledge consolidation, as the learner takes the initiative to discover his skills and prevailing learning style. Through self-authorization, students come to an awareness of own strengths and weaknesses in their progress, while gaining the ability of organizing an individual course (Damsa & Lange, 2019).

The theme of knowledge acquisition and active learning portrays a widely recognized pedagogical theory in education systems: cognitive constructivism. New lecture rooms have been elaborated from the perspective of constructivist learning, which showcases vital differentiation to the customarily designed examples (Olusegun, 2015). Constructivist principle demonstrates the process of building up knowledge through different states, which vary from person to person or emerge in different orders during the acquisition of know-how. Referring to that, the design process of modern learning environments and also post-evaluation measures should effectively credit the stagewise essence of human educative ventures (Imms et al., 2016). Taylor et al. (2009) presents the ideas to justify the employment of student-engaging and enterprising strategy conjoined with the scholarly program as in the following:

1. Empowered student ambition and inspiration.

2. Fostered collegial interaction.

3. Lessened undisciplined and disorderly attitude.

4. Enhanced level of synergy between learner and instructor.

5. Advanced achievement of knowledge acquisition and innovative thinking.

6. Owning liabilities of the personal educational process.

3.2. Effective feedback

The 21st-century standards entail revised pedagogical strategies that would centralize the learners' engagement in the feedback cycle and curricular guidance in favor of collaboration and interactive skills, consequently, of interdisciplinarity (Duban et al., 2018). The studies illustrated that regular assessment practices and a continuous feedback flow between teaching staff and learners promote adoption of the new education techniques (Olusegun, 2015). However, differences in personal competence and cognitive skills decisively induce the response to feedback in educational ecosystems. For that reason, the instruction about critical thinking and the personal capability of processing the feedback defines the final performance in employment of the feedback tools in mutual teacher and learner evaluation. Besides, the character and function of a particular learning environment may address varying meanings of feedback. In addition to that, students expect a certain familiarization with the employee behaviour and professional environments through an effective feedback cycle, within a simulated employment context as much realistic as possible (Evans, 2013; Higher Education Academy, 2012). Thus, including the cross-disciplinary events and issues that take place outside the scheduled lectures would assist reflecting the realities of the world of business. Higher education guiding norms, therefore, shall acknowledge the contributions from different disciplinary fields.

A greater focus on cognitive and developmental psychology will help to develop feedback mechanism and enhance the design of learning environments for maximum accessibility. Considering the cross-cultural and cross-disciplinary nature of universities, an impactful evaluation cycle has to be established (Evans, 2013). In fact, neglected feedback and user opinion majorly lead to the user disappointment in post-evaluation studies. However, constructive assessment could be a fruitful link between the academic employees and the learners as a community, establishing means for deeper engagement of the student (Deeley & Bovill, 2017). Consequently, an inclination in higher education towards the introduction of workplace's culture has grown that offers services such as career development, career events with company representatives, and consultancy opportunities within an expert environment. However, the environmental conditions in which these activities are carried out have barely changed in contrast with the novel pedagogical approaches. Therefore,

evaluation in tertiary education institutes should accelerate for the achievement of a well-administered evaluation strategy (Higher Education Academy, 2012).

3.3. STEM and STEAM methods

Under the scope of interdisciplinary implementations, students are exposed to a complete learning experience on the selected theme, which involves multiple disciplines for critical and extensive appraisal of a subject. The STEM (Science-Technology-Engineering-Mathematics) and STEAM (Science-Technology-Engineering-Art-Mathematics) both appear as interdisciplinary exercises devoted to contemplating a unitary model of the educational training. The STEM approach was first developed and adopted in the US at the beginning of the century in order to regenerate an ambitious movement in new technologies and cutting-edge scientific subjects (Duban et al., 2018). Chiefly, the essential attempt of the STEM approach is to link the textbook with real problems, on the other hand, the STEAM movement pioneers a wider integration of disciplines by incorporating an artistic perimeter (Morrison, 2006; Connor et al., 2015). Another positive outcome on the personal level, besides, has been revealed as students evolving into confident innovators and strong-minded intellectuals capable of operating with new technologies, in alignment with today's skill requirements (Duban et al., 2018).

Eger (2013) notes that artistic creativity blended in scientific education qualifies as a major determinant for innovative thinking in the global industry, since this has been repeatedly emphasized for the economic growth and advanced educational services. The recent pedagogy reforms occurring in many developed nations such as Canada, the US, and Australia have considered STEAM the core of the new methodology in higher education, especially stressing the developments in new fields as digital media, biomedical sciences, and biotechnology. Duban et al. (2018) uncover as well that students reported to be supremely satisfied with the collaborative learning and constructive feedback system in an interdisciplinary environment empowered by the STEAM principles.

The Bachelor of Engineering Technology degree program at Auckland University of Technology organizes a course project called ''The Engineers Without Borders'' (EWB). The structure of the plan calls for the acquisition of design-driven and communicative skills together with the effective utilization of digital tools. Beyond a plain introduction to the engineering topics, the course strives for cultivating a dynamic manner of learning performed as mostly teamwork, where the deep involvement in the real world challenges prompts an apprehension of public responsibility. The case study is deployed in a different location every year and the students are expected to connect with the regional population to seize the opportunity for a role-play activity (Duban et al., 2018).

The MFA Design program at California College of the Arts (CCA) offers myriad opportunities for the Design Futures Lab to serve as an interactive space cross-academic disciplines. The motto is ''Combine critical design conversations with cross-disciplinary studio work and

speculative design thinking.'' Studio courses, which form the backbone of your CCA experience, are typically co-taught to encourage hybrid design structures driven by emerging technologies, the implications of technology-embedded products, material exploration, social media culture, and so much more. Accessibility to state-of-the-art facilities for graphic design, industrial design, and interaction design, one is prepared to do leadership in civic, commercial, and curatorial spheres. Collaborative work in four areas of focus that will shape the future have been envisioned:

- Media and technology

- Materials and manufacturing

- Ecology and adaptation

- Form and aesthetics (CCA, n.d.)

22 Bachelor of Business students in a study program of design major at Auckland University of Technology were encouraged to use problem based and participatory approach of learning with the project called 'Experience Design', a ten-week project fully undertaken by students. The observers in the course duration reported the process outcomes:

> *'Given the short period and the complexity of the projects, students were provided with a structured design process and a set of design methods. During the course, students were required to identify and explore the needs of elderly users, and understand their strengths and limitations in using the intended products. The project also assisted students to engage with broader contextual and social issues in creating innovative concepts. Students were encouraged to use visual storyboarding and digital storytelling of the solution to the use. It helped them to come close and align their thinking with the reality.'* (Connor et al., 2015).

3.4. Definitive terms of interdisciplinary environment

Along with the economic, social and environmental changes, external stakeholders such as politicians and governmental bodies too urge higher education institutes to amend the policies in their learning programs. The notions quoted as "21st-century skills" have been introduced by these external agents to universities' academic planning and service provision for a thorough preparation of students corresponding to the expectations of the future employment mediums (Table 1). Granted the contemporary needs, the acquisition of these hard and soft skills could be attained in blended environments of both formal and informal campus events that reflect the 21st-century terms in **Table 3-1** (Pellegrino & Hilton, 2012). Convenient tools provided by the internet establish the core component of a complex system where social spaces emerge from learning management applications. Thomas (2010) has recently shown an adaptation in characteristics, such as networking and centralized delegation of roles and tasks spurring in rapturous learning spheres.

Table 3-1. 21st-century skills defined by different stakeholders in higher education development (Pellegrino & Hilton, 2012).

21st-century terminology in educational environments	
problem-solving	critical thinking
effective communication	collaboration
self-management	self-starter
deeper learning	career readiness
student-centered learning	next-generation learning
higher-order thinking	creativity
motivation	innovation
informal learning	interdisciplinary learning

Obtaining a decent skill level in more than a single discipline is the core ofcross-disciplinary learning. Implementation of a reform plans for institutional change needs a careful consideration of complex connections and its reflection through guidelines. Redistribution of resources, as well as power structure and reintegration of progressional mentality across campus departments would make commendable steps to take; for instance, decentralization of authority and responsibility within relationships and hybrid campus structures (Clark, 2003). Higher education design quality forum (HEDQF) that was presented in the UK in 1995, strives to enhance the performance in educational institutions. Regular meetings are organized every year to keep the intensive debates on update between professionals from architecture, construction, facility management, and all relative providers (Riley et al., 2010).

3.5. Space and human in education
A shift in architectural arrangements and spatial design recently manifests itself. Flexibility has been indorsed as the keyword in changing environments due to extending variety of newly discovered learning-teaching methods and approach. As commonly defined *hybrid space,* the merge of different exercises with *adaptability and openness* are enables in reconfigurable spaces. Consequently, the central element becomes the space itself in education, which transforms learning experience into socially dynamic knowledge (Imms et al., 2016, p.3-5). To illustrate an example, the incompatibility of workshop environments in design and architecture faculties have been addressed by Imms et al. (2016), which remained almost unchanged in the last two centuries. Evidently, they lack the adequate

quality features, such as sufficient technological furnishings, rooms for casual pitching practices, storage spaces and an animated environmental spirit propelled students to choose alternative spaces over campus workshops (Imms et al., 2016).

In response to intense rivalry in the higher education sector, answering the recent demands play the main role to draw in and keep the best students and staff. The tertiary education context undergoes a change which is more global and heterogeneous in terms of client profile: students and employees. Experimental architecture spearheads function-based and learning-oriented buildings for an improved campus experience on-site. Thanks to this, unique identities of individuals are preserved and represented (Coulson et al., 2014). However, based on the findings of Wilson and Cotgrave (2016) this causes a contradiction for the community culture. In brief, there should be a coexistence of integrity, and variation; maintaining the feeling of community while maintaining unique personalities.

The interdisciplinary setting in academic prompts significantly visible effect on the physical aspects of devoted facilities, both indoors and outdoors (Coulson et al., 2014). According to a study conducted at two leading innovative universities in China, the engagement level of students along with campus setting have the biggest influence on student perception of that higher education institute. Moreover, the academic and social engagement reciprocally promote each other since students remain involved in campus activities for longer (Chan, 2011). The integration of social and intellectual assets is achieved by means of spaces that help building interconnections between users. This is supported by design choices, which influence the learning experience, especially the process of informal knowledge interchange since these environments transmit a personality (Pellegrino & Hilton, 2012). To develop socially interactive contexts, alternative ways to design transition zones should be defined in definitive guidelines. Major types of learning environments for tertiary education have already been identified: simulation spaces for applied learning with technology support, engaging spaces for of interaction on virtual platforms for deeper learning, collaboration-promotive spaces for peer work or casual meetings (Temple, 2008). Various spaces have already been transformed into informally functional zones for work and studies, including connectors such as steps, corridors and campus agoras. These developments are claimed to be closely associated with trending norms of PC-aided knowledge acquisition and task completion, socialized learning and networking (Ibrahim & Fadzil, 2013).

The blend of formal and informal learning environments incorporate a set of coherent, interrelated features to support development of a collaborative ambient in wider educational environments (Pellegrino & Hilton, 2012, p.5). Moreover, the sense of place has its roots crucially in the sense of belonging. The relationship of humans and space develops in non-linear interaction of factors: *development, adaptation, experimentation*. This interlaced system is compressed into a brief scheme of *people', 'place/space', and 'practice'* (Imms et al., 2016, pp.154-55). Besides, an empathetic design must be developed according to user experience (Hadjri & Crozier, 2009). Effective learning happens when activities,

learning actors and the context jointly provide an authenticity of the *conceptual experience* (Herrington & Herrington, 2006).

For instance, Australian authorities are conducting research activities for the development of modern and interdisicplinary learning spaces, investigating frameworks to accommodate an integrated diversity of many disciplines and methods. Robust solutions are inquired to the big question: How is a deep-rooted foundation like a higher education institute supposed to revise and improve under external influencers? (Imms et al., 2016). In Melbourne, the Graduate School of Education initiated a degree course which merges education and design, allowing students from pedagogy and architecture departments to design an innovative space and then evaluate the results **(Figure3-1)** (Imms et al., 2016, p. 168).
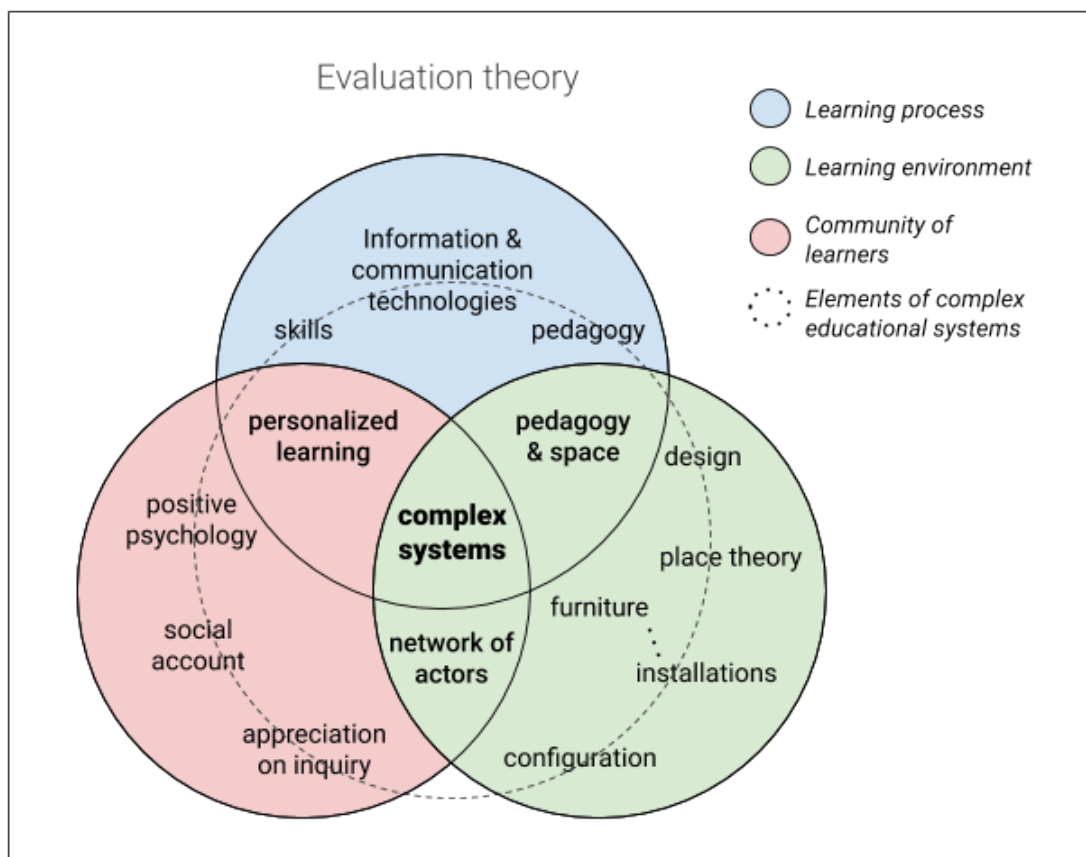
Figure 3-1. Summary and organisation of key theories pertinent to an examination of the role of evaluation in an ESPs practice. Reproduced from (Imms et al., 2016).

The findings from research conducted on students from three different fields of study in Liverpool John Moores University disclosed some dissimilarities **(Table 3-2).** Students from design faculty scored the most crucial factors as *'adaptable rooms for all types of learning'*, *'flexible furnishing for the needs'*, *'dealing with environmental conditions in the space'*, on the other hand *'availability of refreshments'* was scored higher than all other faculties.

Despite that, the unity of some factors was observed. Accessible library spaces, better spatial capacity, revised and easily reachable technological installments concluded were agreed the most important factors. These outcomes affirmed the need for a balance between varying and shared disciplinary units in the campus (Wilson & Cotgrave, 2016).

Table 3-2. Description statistics of students from three different departments in a campus: Art and Design, Built Environment, Engineering (Wilson & Cotgrave, 2016).

Element	Satisfaction mean values of students across disciplines		
	Art & design	Built Environment	Engineering
Formal learning spaces	3.64	3.92	3.73
Informal learning spaces	4.15	3.71	3.94
Lecture rooms	3.58	4.06	3.94
Specialized labs	4.15	4.10	4.48
Clear visibility & audibility of the teaching instructor in rooms	4.15	4.15	4.42
Library availability	4.54	4.35	4.36
Clean and decent toilets	4.75	4.48	4.58
Social spaces	3.78*	3.66*	3.57*
Flexible configuration of learning and activity areas	4.32	3.85	3.85
Adaptability of furnishings	4.34	3.35	3.67
Ergonomy of furniture	4.25	4.10	4.30
Availability of suitable and latest technology tools	4.71*	4.38*	4.85*
Pleasant temperature	4.46	4.27	4.39
Natural interior lighting	4.56	4.19	4.06
Control over environment	4.34	4.06	4.09
Commodiously roomy spaces	4.59	4.21	4.33
Availability of drinks & snacks	4.32	4.00	4.24

*mean value average of closely related factors that are given in the source data.
italic values indicate the most critical 10 factors by students from each discipline.

Success in designing educational spaces will come from exploring adequate procedures. Oftentimes, spatial units are overlooked in a trade-off with operational concerns. However, several fundamental questions would help decision-makers in enviromental design:

Q1: Is physical space really needed or a virtual one would be compliant with the learning activity held in there?

Q2: Which ways can this space motivate users to study more efficiently and validate their needs in terms of comfort and convenience?

Q3: What kind of tendency will this space reveal in the scale of solitary vs. collaborated studies?

Q4: How this space will assert the power order against knowledge status among users?

Q5: What kind and level of social interaction is intended in this space? (i.e social or reputational hierarchy)

Q6: Generally speaking, how competent is this space to improve the overall learning experience? (Bennett, 2007).

3.5.1. Factors in the learning process

Traditionally, specialization and expertise in diverse faculties split the disciplines radically into monastic units while eliminating potential interactive encounters, thus, collective creativity (Hebbert, 2018). Van Baalen & Karsten (2007) refer to a phenomenon called 'Disciplinary Paradox', asserting that the disciplinary units in higher education facilities are in fact underlying elements of a potential interdisciplinary development. For decomposition of the repressive hierarchy structure, universities can harness the diversity in specialties, which may benefit the coexistence of learning modes in higher education environments (Sà, 2008). Just as standardized study plans for a specific degree course, learning spaces too let the confines dissolve as liberated from typical study rooms. Today, campus users benefit from learning spaces to enjoy a leisure time as well as to fulfill academic tasks (Thomas, 2010).

Among higher education institutes, a shared discontent was identified: monotypical learning halls discouraging student engagement, to host more students than the given capacity of standard classes for economic concerns. In such environments, students develop a lowered self-image of being the 'lightweight' individuals in the crowd, which leads to minimal interest and underperformance in learning (Beichner et al., 2000).

Discovery of the corresponding interests and shared purposes of departments bolsters an interactive and integrated experience spawns a higher-order learning process in interdisciplinary contexts (DeMarais et al., 2013). Through deeper learning, an individual is steered into a capability of applying the base skills in new problematic situations (i.e.,

knowledge transfer). Deeper learning approach usually comprises shared learning, which also develops as transferable knowledge. Concerning that, research-based teaching methods have been recognized with strategies such as: Utilization of multiple representations techniques, such as diagrams, numerical illustrations and simulations; encouraging elaboration and explanation while supporting them with guidance and feedback (Pellegrino & Hilton, 2012, p.5).

The conceptual divergence of study fields resulted in institutionalized and unadaptable curricular programs (Damsa et al., 2015). Stationary learning and stagnant evaluation methods make critical thinking no longer pleasurable for students, therefore, there is a lack of auxiliary skills in students abilities (Pillai et al., 2019). Current education institutes still follow study programs that obligate the learners to achieve status or position, rather than furnishing them with really effective skills (Watson, 2019). As theory and practice are recognized as mutually working elements in the learning process, Engeström et al. (1995) suggest a two-fold formula for expertise acquisition: articulated knowledge transfer through pure data, on the other hand, accumulative learning within social environments by transmission and communication. Both combined, systematic knowledge transfer in individuals happens while providing a horizontal level of skill sharing in a cross-disciplinary context, which promotes learning in collaborative interaction and necessary soft skills acquisition (Engeström et al., 1995). The catalyst conditions leading to the learning process comprises of students and learning environments to accomplish a more complete learning process. The byproduct of this sequence is interdisciplinary thinking by a synergistic approach. The analysis **(Figure 3-2 & Table 3-3)** proposes how each component empowers various conditions in interdisciplinary thinking (Spelt et al., 2009).
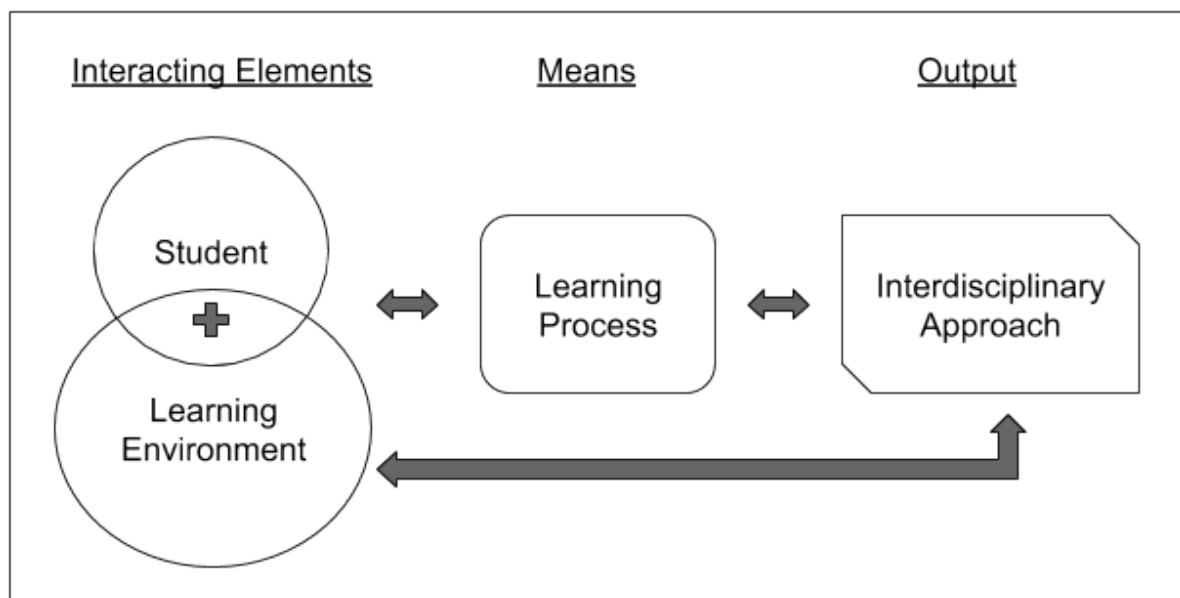

Figure 3-2. Student-environment relationship for a functional interdisciplinary attitude (Spelt et al., 2009).

Table 3-3. Vision of the components and the relevant conditions of them for interdisciplinary tertiary education (Spelt, 2009).

Potential subskills and conditions for interdisciplinary higher education		
Interdisciplinary mindset	Knowledge	Both in disciplinary and interdisciplinary paradigms
	Skills	Higher-order cognitive skills
		Communication skills
Student	Personal traits	Curiosity
		Respect
		Openness
		Patience
		Diligence
		Self-regulation
	Prior experiences	Social
		Educational
Learning environment	Curriculum	Balance between disciplinarity and interdisciplinarity
	Teacher	Intellectual community focused on interdisciplinarity
		Expertise and consensus on interdisciplinarity
		Development in teamwork
	Pedagogy	Active learning and collaboration
	Assessment	Students' intellectual competence and development
Learning process	Pattern	Gradual advancement
		Linear
		Iterative
		Through milestones and questions
	Learning activities	Achieving interdisciplinarity

Learners need intense contact with practical applications throughout the learning process. A lecturer states that experience and multitude of perspectives acquired in specific field disciplines first, facilitate cross-disciplinary cultures in universities. By then, learners need complex environments and solitary time for discovery of creative uses of that knowledge (Reynolds, 2012). The conjoint modes of learning are stimulated by the influence of flexibility, innovation and sociability with positive effects to student performance (Ehmann et al., 2012). Campus should enable self-regulated schedules and active role partaking in problem-solving. For instance, absence of rigid exams and fixed study plans help people organize their own time and sources of the learning experience (Darling-Hammond, 2009). As reported by the project in the UK in 2012 by Quality Assurance Agency (QAA), the custom-fit educational experience is eminent to maintain the individualism and personal needs (Kandiko & Mawer, 2013).

3.5.2. Socialization

As a specific culture determines the complete set of values, assumptions, and reactions of a person, it certainly has an influence on how someone learns and communicates. Therefore, a person can only feel in comfort when a learning environment is in correspondence to some degree to his cultural background. When an environment is capable of supporting multiplicity, the outcome will likely be openness of minds, critical thinking ability and increased awareness of the surroundings (Guo & Jamal, 2007).

However, a truly interdisciplinary knowledge expands beyond institutional boundaries through interaction with society and different external segments (Frodeman & Mitcham, 2007). Close interpersonal relationships and effective communication combined, are likely to present a more open environment for interdisciplinary connections (Franks et al., 2007). Appropriate space is needed to facilitate the intellectual exchange between colleagues from diverse departments, which would trigger interdisciplinary activity. To set an example, collective unions and interdisciplinary partnerships have been indispensable elements of modern learning environments. Spaces shall be enabling casual exchanges and informal gatherings to vitalize interpersonal connections. Community buildings emerged upon factors as physical proximity and shared interests (Friedman & Worden, 2016; Dawson, Burnett & O'Donohue, 2006).

Concisely, today's design alterations respond to five profound challenges of contemporary campus life. First, sustainability: the inclusion of carbon-mitigation in universities' performance measures encourages a layout that is compact, accessible and energy-efficient. Second, recruitment and retention: universities are in fierce competition for staff and students, and since generational preferences have shifted towards urban life-styles and consumption patterns, so must they. The third factor can be summed up in the words knowledge economy, and reflects awareness of how universities can enhance regional productivity through research spin-offs and business support. The fourth factor is globalisation. The more knowledge is globally networked, the greater the demand for face-to-face contact. The final factor is epistemological. Today the frontiers of science and creativity lie across the boundaries between disciplines. The most fertile knowledge environments are not cells of specialisation, but interstitial spaces where different specialities come together - which is exactly the role that urban environments were historically created to fulfill.

> *"Today the boundary between the university and the city must become porous, or better, non-existent. In a healthy knowledge society the university becomes the city and the city becomes the university."*
> (Schweneius et al., 2017, p. 21).

4. Interdisciplinarity in Learning Environments

The entire scene of space design and use has been subject to a serious change. Work that has been done in dedicated rooms only now is sprawling out of physical boundaries, environments are transforming into hybrid spaces of evolutionary freedom supplied with recent virtual and physical opportunities (Imms et al., 2016). Inevitably, casualty and coziness of atmospheres that offer technology-aided learning rather than formal and stagnant spaces have been trending, as collectively stated across higher education users (Rytkönen et al., 2017). The pressure for change in higher education space qualities has been more abrupt than any other built industry (Coulson et al., 2014), since then the executives commenced favoring mixed-use and cross-disciplinary options in the institutional desicions, to facilitate collaborative actions (Joyce et al., 2010). All these developments effectuate a major re-imagination of learning environments as blended domains, since the functional and symbolic value conveyed by communal spaces validates the creation of them (Kandiko & Mawer, 2013).

The network that arises upon cross-boundary activities seeks an intensified impact through critical interactions among key players from different fields, on the contrary of experts from segmented study fields (Knight, 2011). Continuous learning is enabled by means of consciously procured educational territories that host occasional and numerous interactive contexts such as group events, seminars, exhibitions (Imms et al., 2016, p.45-46). It was also found that knowledge interchange and common methods still remain important but beyond those, human qualifications such as sharing a purpose and cooperative action foster further development of fusion identities. Not surprisingly, a frequently mentioned request from students is having a coequal state with staff as an alliance of shared purposes which manifests a fundamental principal in collaborative and interdisciplinary education, as reported in 2012 by the Quality Assurance Agency(QAA) (Kandiko & Mawer, 2013).

However, individual expertise and systems thinking are two colliding ideas. Usually a certain way of organizing people results in the same outcomes, regardless of the individual qualities. The ability of envisioning the outcomes of these interactions in the long run, rather than imagining each element isolated, prevails individual roles within a community. Therefore, a healthy equilibrium between personal awareness and collective thinking determines the degree of quality and success of the modern learning experience at cross-disciplinarity (Herrington & Herrington, 2006).

4.1. Interdisciplinarity

Universities demonstrate fragmented single disciplinary portions of knowledge by tradition. An abundance of possible perspectives that might otherwise have supported students shall be enabled beyond those boundaries and single-track thinking in education. An alternative definition was advocated that collaboration is the result of reciprocal involvement of disciplines, which would not have been achieved solitarily. Instead of isolating students to

individual tasks, even so there is availability to promote collaborative action in higher education institutes, proper tasks distribution and communicative technologies for joint activities (Herrington & Herrington, 2006; Bryan & Klein, 1998). Baalen and Karsten (2007) express that as much as the disciplinary fragmentation reflects the conceptual disconnection of systems and specialty fields, it is possible to blend the domains of expertise through judicious procedures planned by the collaboration of learning investigators, the campus staff, the external society and university governing officials together.

Multidisciplinary: a partnership of different fields, not assuredly through integration.

Interdisciplinary: multiple disciplines compound within an interactional framework and make a one (Ivanistkaya et al., 2002).
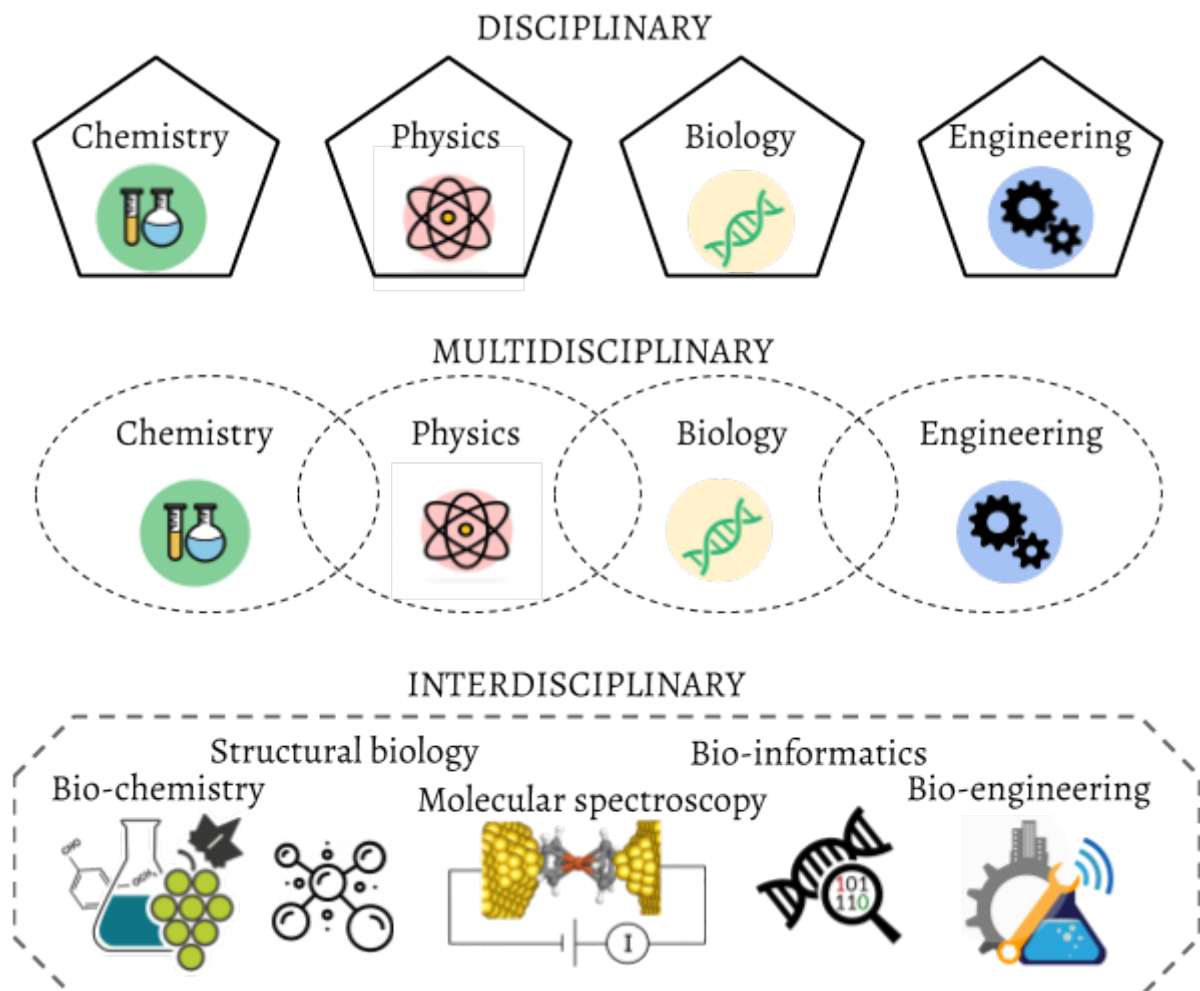
Figure 4-1. The blurring boundaries and fusion of individual disciplines that have been once fragmented as departmental units, in today's research and education environments (Neuman et al., 2013).

Whereas multidisciplinary brings in a number of disciplines on a problematic case, where cooperators share knowledge within own disciplinary borders without innovation, interdisicplinarity conjoins dissociated subject areas, vigorously driving them to cross boundaries of each area in order to achieve a novel specialty field. The collusion of divergent methods and approaches of each involved knowledge area embodies innovation (Neuman et al., 2013).

Benchmarking

Disciplinary

Meeting
5,0%
Office
20,0%

Lab
45,0%

Core Lab
25,0%

Lab support
5,0%

Multidisciplinary

Meeting
10,0%

Lab
30,0%

Office
20,0%

Lab support
10,0%

Core Lab
30,0%

Interdisciplinary

Meeting
15,0%

Lab
25,0%

Office
25,0%

Lab support
15,0%

Core Lab
20,0%

Figure 2-2. The changing design trends of spatial ratios in HEI research facilities given as results of benchmarking a critical number of facilities.

Lab support: *has diverse daily uses, flexible enough to accommodate rising space needs.*

Core: *areas of highly specialized equipments and infrastructure (Neuman et al., 2013).*

1.a. Benefits of interdisciplinarity

Educational exposure to numerous disciplines offers students acquisition of hard and soft skills. The structure and scope of interdisciplinary programs range from explicitly organized to a liberated form of opportunities across departments. Clear prescri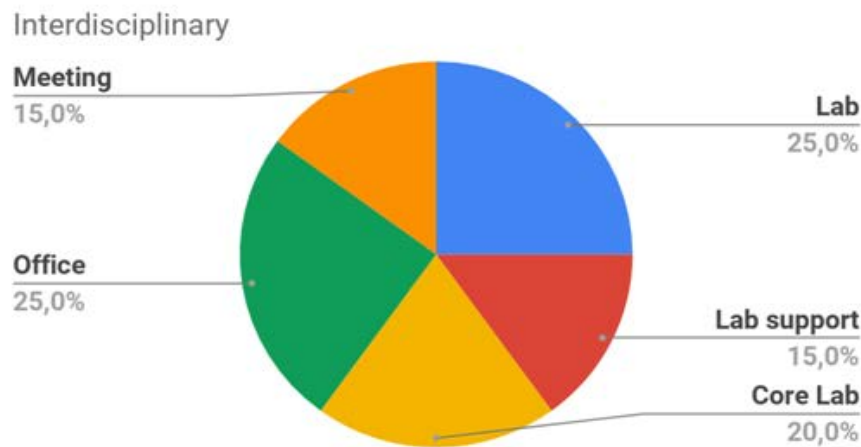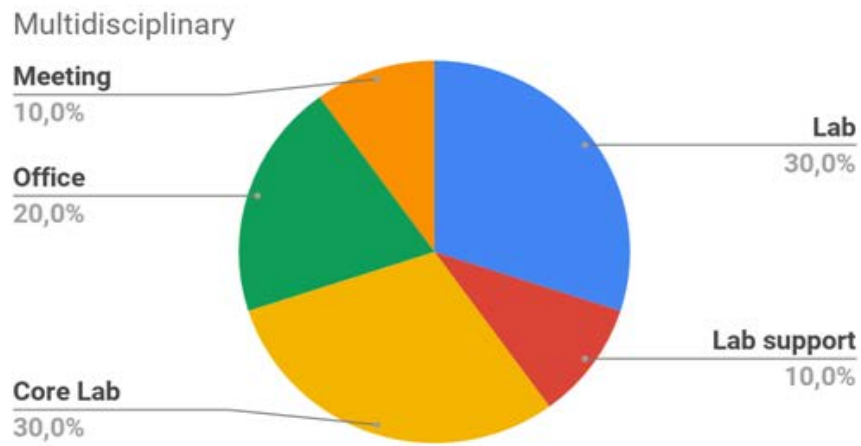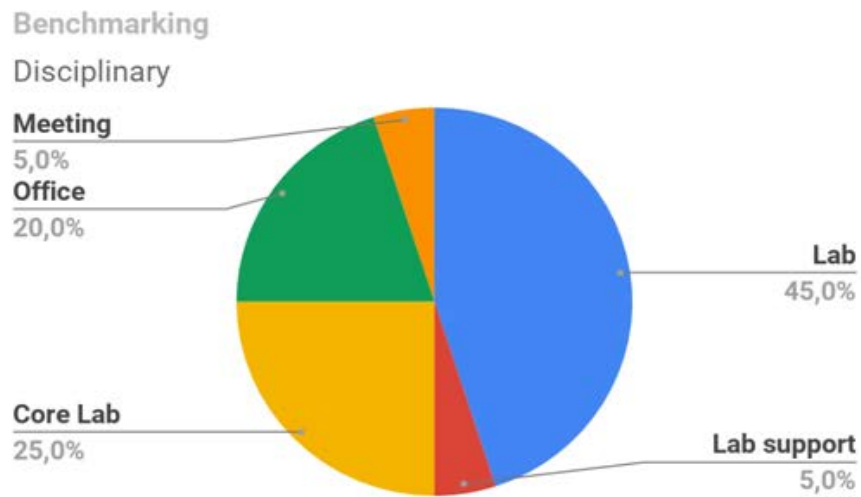ption of which elements impose interdisciplinarity will help inquiring outcomes (Rhoten, Mansilla, Chun & Klein, 2000). Interdisciplinary knowledge happens in a challenging context, which addresses baffling problems to be solved in a cooperative and creative framework of a breakthrough. Such a dynamic approach leads to an improvement in institutional performance and vigorous efforts in cross-stakeholder partnerships (Franks et al., 2007).

1.b. Lifelong learning

Modern age endorses education of beings for all-rounded learning, and educational spaces work in compliance with the accessibility principle. Human education extends beyond the fundamentals in basic sciences and linguistics, prioritizing the needs of wider population. Projects support public accessibility and also ingeniously accommodate multifunctionality within one space (Coulson et al., 2014; Darling-Hammond, 2009).

In the professional arena as well, interdisciplinarity has become the mark of genius of knowledge output. Thefore, the correct introduction of it will define rising generation successful engagement in interdisciplinary activities (Borrego & Newswander, 2010). Even when hiring in professional life, it is also underlined that skills at interdisciplinary application are a must, on top of a college degree. If not so, the management departments organize events and further training activities for this purpose within the corporate program. These cases also encourage the cross-disciplinary education plan in universities while getting industry players involved in the process of an overhaul (Lee, 2014).

As architectural features that encircle us have grown a determinant of the spatial stimulation, curiosity element in design of learning environments accelerated incorporating fun and engaging elements (Ehmann et al., 2012). Recently, people are encouraged for improvement at any age and stage. Achievement gap among people can be drastically reduced thanks to this kind of reforms (Darling-Hammond, 2009). In consequence, a stretched educational experience invites all wider communities, proposing a joint climate of university students, field experts and curious citizens (Neuman et al., 2013).

Inspired by lifelong learning movement, a project called Learning Street was realized on one of the campuses that provide Tertiary and Further Education (TAFE), in Australia. This new application combines curricular higher education programs with vocational courses in the same place, which aims for increased success in deeper learning. Learning street forms a significantly flexible and continuous space on campus, comprised of varying functions that accommodate anyone and any kind of activity from specialized knowledge acquisition to group learning or to cover an immediate need of space. External players are always

cherished in particularly assigned zones in case of collaboration requests to extend the career possibilities for users (Taylor et al, 2009).

The term 'communiversity' is suggested for such a scholarly body where actors are untypically challenged in a joint environment of theoretical teaching, practical activities and sense of community. Since empirical learning is needed to gain know-how, experiential engagement would assist students in and out of their community in order to feel connected to the real world (Weidner, 1973). The University Square Project, a partnership between two educational institutes, offers a wide range of bachelor degree programs that are structured as part-time or evening school with the contribution of each partner university in the context of extended and inclusive education. Alternatively, certificate courses and foundation degree courses are being held as well. The study subjects vary from accounting & business to information technology systems. The robust vision of the collaboration emerges as *"to create a major educational hub to meet the growing aspirations of local people at a time of great change and opportunity in east London"*. The joint facility also provides booking of study rooms and spaces for meetings, training sessions, conferences and events to the wider society, who is eager to self-improve.

4.2. Initiating interdisciplinarity in universities

The inter-departmental gap is decreasing with the cross-fertilization of disciplines for research and aspiration for innovative knowledge. In this respect, in the last decade closer proximity of diverse faculty buildings has gained strategic importance on campus. As consequence, many interdisciplinary facilities have been realized, which showcased its interactive character on open-plan labs, social common spaces and shared infrastructure. Availability of public spheres such as the connecting pathways, squares, and green spaces that are carefully implemented on-campus that engenders a distinctive sense of place in a university environment for fostering cores of interactivity (Coulson et al., 2014).

However, higher education institutes need to walk the students through the comprehension of interdisciplinarity, otherwise it is left ineffective and powerless in achieving its goals: an autonomous environment of constant research, exploration and creative production (Borrego & Newswander, 2010). Poly-contextual and multidisciplinary establishment are needed to break the regular pattern of top-to-bottom order and empower cross-boundary activities (Darling-Hammond, 2019; Engeström & Kärkkäinen, 1995). Values to substantiate efficient and collaborative cross-disciplinarity: competitiveness, interculturality, rapid dissemination of innovative ideas (Knight, 2011; Holley, 2009).

Table 4-1. Strategies in different aspects in a higher education institute towards interdisciplinarity (Holley, 2009)

Strategy for change	Transformation of campus culture into interdisciplinarity	
	Definition	Example
Support from the board	The head procures resources, updates the institutional vision, pioneers innovative initiatives.	Interdisciplinary culture is established via strategic planning and collaborative activities.
Collaboration in decisions	Many stakeholders are participants in the process of decision making, proposing own ideas to debate on.	Inner and exterior actors are organized in decision making cycle, interdisciplinary projects are sponsored in priority.
Flexible attitude	Modifiable and opportunistic approach is enabled within a flexible mindset of the leaders.	Planning and funding of favorable occasions in physical spaces and tools necessary to develop an interdisciplinary culture in the institute.
Training of all stakeholders	Diverse skillsets and knowledge are required for each participant group to render the change sustainable.	Promotion of interdisciplinary academic actions, supporting individuality in teaching and learning modes.
Actualization	The progress is tracked and underlined by stages through achievement of realistic goals in the course of change.	Realization of interdisciplinary projects, design of multi-purpose zones, shared workshops and inviting experts active in cross-disciplinary fields.

The availability of collaboration-oriented spaces and awareness on cross-disciplinary work among faculties should be promoted in campus communities. The initiative has to do more than just streamlining people to meet in an informal ambiance, and more than encouraging them to interact within everyday dialogues, but rather around personal interests. (Borrego & Newswander, 2008; Joyce et al., 2010). In this manner, interdisciplinarity will be encouraged by creating institutional groups or joint ventures of close associate relationships (Friedman & Worden, 2016). Occasional installations and in-built areas on campus provide informal zones for casual interactions. The shared time and experience create closer bonds between fellows (Ehmann, Borges & Klanten, 2012). Beyond university borders, cross-organizational partnerships as well would engender a collective consciousness (Educause, 2010; Kezar, 2005).

A great example to public-private organization partnership can be mentioned: the Creation Center of Telekom laboratories in Germany. At its sites in Berlin, Darmstadt, Budapest, Be'er Sheva (Israel) and Vienna, T-Labs sits amongst a world-class host of universities, startups, investors, research institutes and corporate innovation hubs to jointly shape the future of communication services. This joint institute, Telekom Innovation Laboratories (T-Labs), was initiated as public-private cooperation of Berlin's Technical University and Deutsche

Telekom, to implement mutually beneficial research and development activities in a visionary and interdisciplinary setting for the ICT sector. An invigorating habitat is surely promised to the users with this interior flexibility, consolidated by the spaciousness and the community spirit. Both parties benefit from this partnership: for university associates to expand their skill set and get the chances of future employment, and for the private company to proceed towards cutting-edge projects from the creative minds. Since 2017, the T-Labs focuses on three main topics that are in the global agenda:

- Blockchain and Smart Cities

- New Media Experience

- Deep Learning / Machine Learning (Telekom Innovation Laboratories, 2014).

Various studies validate that innovative steps of development require a strong triangular relationship of university, industry and governing authority to reach the best potentiality (Comacchio, Bonesso & Pizzi, 2012). Universal lessons are inferential from campuses around the world about how to better advocate interdisciplinarity. The flexibility of spaces may allow the unplanned knowledge sharing and opportunity of collaboration to flourish (Friedman & Worden, 2016). For instance, at the University of Buffalo, NY, it was suggested that hub concept could be an answer to future objectives and serve as a spearhead modeling for such learning spaces. Three main approaches emerged: *teaching hubs* for empirical learning grounded with education technologies, *learning corridors* that take advantage of circulation and connection spaces as informal interactions, *faculty hub* creates a joint realm for many for interdisciplinary studies and groupings (Imms et al., 2016, p.49).

Modern educational guidelines across many countries such as the UK, US, Finland, Denmark and Australia; determined common themes: Customized curricular plan, learner-centred education and equal integration of both individualized learning - but in a medium of meaningful network of social relationships in an interdisciplinary environment (AIA, 2006). Neuman et al. (2013) highlight chief steps for creation of collaborative and potentially interdisciplinary environments:

1. Programming of activities that affirms the encouraging initiatives toward collaborative team-up, which is formed around universal or local problems. Their definition of informality level for smoother decision making on designating human experience happening inside.
2. Individualistic elements that shall be included and given priority to in these environments, for instance; which digital and tech-infrastructure to install or where to conclusively position them in the main planning scheme.
3. The articulation of technical aspects and structural applications to healthily balance out adaptable elements against rigid arrangements.
4. The clear description of institutional measures and terms in those implementations (Neuman et al., 2013).

According to research results, students acknowledge and appreciate spatial inventions and purposefully well-thought design attributes. Moreover, the success outcomes are directly linked to the level of application of interdisciplinary codes in learning environments; owing to lessons from an experimental collaboration of architectural and educator specialists. Chapters suggest in the following:

- Natural and ecological elements in design: an ideally outlined space organization bridges learning practices and campus environment, complementing them to as a whole. Daily operative tasks and even design choices are in harmony with institutional morals and values.

- Flexibility: ability of spaces to effortlessly modify or change functions with respect to the purpose or activity in demand, responding to immediately emerging capacity shortage and multiplied educational needs 24/7.

- Local community involvement: a symbiotic engagement between the local community and campus community enables a flow of shared knowledge and resources, creating an educational village.

- User involvement in entire project: active participation of future users should be ensured from the beginning to the end of the design and realization stages, for the design team to obtain healthier insights and real needs from them. This suggests additionally that the sense of belonging planted in participants gives rise to their overall awareness on the educational environment, to be more thoughtful and well-disposed while making use of it.

- Active and continuous on-campus learning: the creation of stimulating and inspirational spaces outside scheduled lectures. Disregarded and overlooked corners, circulation spaces, larger gateways and entrances all possible spaces to lead to dynamic and useful gathering spots.

- Furnishing and amenities: as these installations are the first intimate interaction surface between the user and the space, it is considered vital for the environment to be capable of assuring flexibility and alternative modifications (AIA, 2006).

4.2.1 Urban campus

Education plays a key role in the sustainable development of the campus, city and the region (Lozano, 2017). Modern knowledge practices are displayed in high-density urban centres where work is disseminated around city network. Authorities provide a wide range of services for the fulfillment of their daily tasks in both in diverging individual or collaborative manners. Educational places are not mandated with a conventional stricture any longer,

thus, the subject occupants have more freedom choice of where, how and when to carry out their studies. Hence, the meaning of place in campuses evolve with the present circumstances of conducting innovative studies for knowledge (Rytkönen, 2016). Universities originated in cities, and the fame of ancient seats of learning then used to be –and still is- synonymous with their urban locations: Padua, Bologna, Salamanca, Oxford, Paris, Göttingen, Cambridge, Uppsala. Cities and their seats of learning were physically intertwined, whether in the mediaeval colleges and faculties whose front doors opened onto the street, or the post-renaissance universities set in monumental classical edifices that defined urban centrality. However, the innovation quickly grew in. Around the time of the millennium a radical design shift occurred, a knowledge culture that has transformed the relationship between cities and universities. Campuses turned into concentrated essence of all the forces influencing the incubation of knowledge. Inner-city universities inclined to think of themselves as forsaking enclosures to allow mingling with adjacent neighbourhoods, turning buildings around to face outwards and making services available to local residents in scope of the revival of utilitarian urbanism. Campus designs offered flexibility for expansion and the emergence of new disciplines, they meshed with twentieth century transport and communications technologies, and they echoed the modernist zeitgeist of sunlight and greenery. Soon the word campus had become synonymous with a university itself, whether in or out of town. Formal streets and squares have been replacing the officially-undefined natural landscapes of the campus; the cafés and restaurants of street-based, mixed-use buildings provide active frontage onto the public realm; the car-parking areas that were such a prominent feature of the twentieth-century campus are being scaled down in response to the more sustainable transport habits of the millennial generation (Schweneius et al., 2017). To sum up, higher education institutions play a central role in both the city's current development and for its future vitality, as they are hubs of new knowledge creation and raise new talents. Hence, the city cooperates closely with the universities and student Networks within the city. For the given reasons, eventually, physical setting of a campus becomes decisive for the accessibility plan and effective arrangement of the university territory. Principle features of a city context became a set of decisive force in planning and mapping out the campus program, such as common facilities, transparency of events and shared outdoor spaces (Coulson et al., 2014).

4.2.2 Technology and virtual spaces

Digitization and recent technologies have dominated the operation tools and processes in the productive activities of modern human. In the era of highly technological instruments, the functionality obligates places to alter towards modernization and globalization (Sannino et al., 2009). People work outside allocated places, similarly, students as well choose off-campus places rather than conventional study halls. This addresses the need for revitalization of spaces (Berthelsen, Muhonen & Toivanen, 2018). The report published by Futurelab project articulates the reinvention of learning spaces this way: the representation of understanding modern people's choices of learning methods, welcoming new possibilities

beyond a dynamic design and ergonomic furniture. The feeling of 'space' turned into something *virtual as much physical* in opposition with how it had always been (Imms et al., 2016, p.108,109; p.47,48).

Redefinition of learning spaces forms around the idea of polycentrism, which introduces nimble interior elements for rapid adjustments and besides appropriately assembled ICT for practical resources access (Imms et al., 2016, p.6). Hybrid learning environments have been now commonly integrated into tertiary education spheres thanks to students that are more competent with IT-related tools and selective for modernized learning places. Some principles are nominated to benefit these blended learning spaces better: consolidation of knowledge by mixing up diverse methods of learning (lectures, debates, online and material activities). Besides, online learning materials are accessible to anyone at any level of in any topic. The main concern has become how to transform it into practical skills and innovative ideas. Modern higher education institutes intercede in translating it into meaningful solutions to complex problems that lay in the fusion of disciplines (Neuman et al., 2013).

The proper and necessary integration of technological changes in university campuses begins with the entity vision which directly translates into a revision of spatial typology variation (Haggans, 2015). IT integration plays the key role here extending through every aspect in its implementation within institutes so that the best value will be fully ensured. The organisation EDUCAUSE also testifies that further assimilation of digital means into educational environments fosters innovation. The approach aims for amalgamating digitized schooling, correspondence of manifold mobile devices, self-governing studentship and socialized proactivity among participants in both virtual and material environments (Imms et al., 2016). Henritius, Lifström & Hannula (2019) revealed with their study the direct correlation of campus users' satisfaction level with their emotional perception of the virtual campus environment, with an inspection of the data gathered throughout 15 years since 2002. The supposition of today's students reflects the natural means of learning they have embraced: a flexible curriculum of activities and the liberty of choices for learning in a personalized manner, in a blended medium of cloud-based and physical elements. This fact imposes on the universities the necessity to expand the computerized favouritism in education with other internet-wired solutions. Plus,students now are wanderers that are able to access anything anywhere thanks to this wireless connection possibility. For that reason, many universities have developed extraterritorial continuation of their campus spaces (Imms et al., 2016; Neuman et al., 2013).

Social networking platforms, other than individual communication networks, act as a tool for institutions to secure a perpetual connection with the followers and the rest of society as well. For this reason, the tertiary education sector chose to utilize the means of social media to be able to intercommunicate with the Millenials, who has grown into the main target group of today's higher education facilities. The statistics demonstrate that the average time dedicated to internet media as around 220 minutes per day, by millennial consumers in

2017. Consequently, higher education organizations prefer adopting digital communication and marketing instruments with the intention to bring the physically and timely secluded people together on virtual spaces (Kumar & Nanda, 2019).

4.3. New generation learning environments

Hybrid learning environments have been now commonly integrated into tertiary education spheres as students are more competent with IT-related tools modernized learning places. A keu principle was nominated to benefit these blended learning spaces better: consolidated knowledge by mixing up diverse methods of learning (lectures, debates, online and material activities). Various facility management studies verify that in places where the end product is knowledge, spaces reflect personal choices about how and where to perform the task. This expression displays today's freedom of working in any location such as hubs, integrated centers, co-working or simply from home (Rytkönen et al., 2015). Especially in urban campuses with a high proportion of commuter students, hub centers offer all elements of education within the campus experience (Coulson et al., 2014).

New breed learning environments come in different forms and combination of elements, that could potentially be applied in diverse ways in distinct contexts. The most recent typical cases are fusion hubs, think-tanks and informal study-rest spaces, which refuse long-established perception of educational rooms or lecture halls. The core idea is the same: encouraging interdisciplinary activity across the institute, as a comprehensive center or limited to the program regardless of being obliged to a certain scale implementation. These formations can house specific or mixed activities, serve to a single purpose or multiple, may be developed for a certain timeframe intentionally or put to test for feedbacks before next verdict on its future (Weidner, 1973; Ehmann et al., 2012). Hybrid spaces assume multidisciplinary contexts in which different groups from society interact, as well as sustain innovation opportunities in collaborative partnerships (Iyer-Raniga, 2019).

4.3.1. Library: the campus node

The university libraries have essentially remained as the places where solitary studies happen through systematic resource investigation. Although, as today's student profile prefers a more casual setting for didactic studies, educational institutions propose blended study fields more than ever which highly demand collaborative tasks for learning. Accordingly, the library turns into the place that is sitting at the core of a lively and stimulating campus site with an informal context, combining work and leisure into one. Furthermore, now the digitally stored resources and publishings save a lot of time and space for all the users. This liberates room for any other ingenious activity or installation in library facilities, and indicates to future transformation in the same context with alterations in people and technology (Neuman et al., 2013; Ellison, 2016). Seal (2015) also testifies that the library buildings in a higher education facility have always been places of heavyweight warehouses for keeping printed and written collections, rather than providing effective

consultancy services (Wilson & McCarthy, 2010). Ehmann et al. (2012) show that internet-friendly resource supplies such as e-readers and digital tablets permit the library users to consult the mass-stored archives much more easily and free of physical drawbacks. As campus spaces have been transforming into highly social and growing section in the society by the turn of the millennium, the library is situated in the heart of campus as a response to the accelerating demand for accessible information and welcoming spaces. Seal (2015) further explicates this trend with an example: An information common created by one of the libraries in Chicago was installed as a single facility, as an extension of the central library, that is based on an extensive database of online information, where the connecting corridor in-between was inaugurated as a cafè. This project proved a huge accomplishment for its utilization and satisfaction feedback, thanks to these core principles specified in the origin of the plans to found a student-centred library:

1. Spaces to study, work and be together
2. Up-to-date technology
3. Robust network connectivity
4. Library and technology expertise
5. Information resources.

The researcher also stated that a flexible arrangement and operational foundation to the facilities will ensure the evolution of the traditional library regardless of the future transformations in education and technology (Seal, 2015). The significant changes the libraries are subject to in this decade could be given in several designations:

- Multiple levels zoned from consultative to quiet

- Flexible spaces to change in time, supporting a large range of learning styles and interaction

- Combined with other learning support services

- Automized storage, preservation and digitization labs

- Complementary consultation, technology, and printing services (Ehmann et al., 2012).

Umbach and Wawrzynski (2005) mention in their finding that higher education facilities, which apply the methods toward effective and collaborative activities for learning, and attain increased student devotion in their studies. The review of contemporary library projects reveals the most prominent features as:

- Floors and sections dedicated to each purpose, from consulting services to silent concentration rooms.

- A certain level of flexibility for planned and non-anticipated modifications.

- Design choices that recognize and value both different learning modes and leisure time needs.

- Provision of complementary services, user-friendliness.

- Automation of bibliographic archives, availability of both digital publishings and printed resources.

- Appropriate consultation and digitized printing opportunities (Neuman et al., 2013).

4.3.2. Temporary and long-term solutions

In case of unanticipated events or a sudden fluctuation in capacity demands, the institute should be able to act in response to those in time. The required flexibility can be supplied, by installing modular space units. Alternatively, specifically programmed rooms can house various functions, such as opening up an exhibition space on campus to host a series of lectures/guest events. In 2010, University of California commissioned a seasonal installation in the new centerpiece of Gallery B of Berkeley Art Museum: a hybrid of sculpture, furniture, and stage. BAMscape is meant to operate as an art piece in the museum, as a result of architecture and furniture design blending to create a socially interactive element. It is a group of module fittings that enables casual leisure or study time, fabricated exclusively with special laser cutting techniques piece by piece. Thinking about contemporary user's moods, plug sockets along with the internet connection are integrated inside each unit, as the featherweight foam material allows it pretty well. The creator of the design, Thom Faulders, explains his vision as combining functional design with research and experimental projects, in order to stimulate "*dynamic relationships between users and environments.*"

Figure 4-3: BAMscape, a space for interaction, performance, and improvised experiences (Clark, 2010).

Long term flexibility instead, calls for an adaptable space design that is qualified enough to expand and transform as future needs evolve. From an architectural perspective, the most frequently applied construction method of flexible spaces is building the structural frame of the project sturdily, but leaving the interior configurations open for further modifications (American Institute of Architects [AIA], 2006). An equilibrium of both maintenance and innovation is a key solution for a successful campus modernization (Coulson et al, 2014).

4.3.3. Hubs

Hub concept evolved around the idea of a functional fusion of several dimensions, based on the idea of increased flexibility and vague spatial distinction to help its community to keep the ambiental culture alive. Functionally, hubs are driven by the increased economic concerns of the modern world as well, such as economic competitiveness, profit-making concerns, acquisition of soft skills and further professional training (Knight, 2011). Hubs generate an active and public center experience for students, including the favoring equipment with internet connection and other dynamic learning instruments. The modern hub building has been credited to learning environments substantially in the UK, New Zealand and Australia, who mostly named it so in practice. Hubs epitomize the evolution of university spaces shaped by spatial transformation that stems from two typical campus ecosystems: library as the formal studying space and student union rooms serving a ground for leisure gatherings. A single place supports collaborative activities and informal encounters with socializing areas (Coulson et al., 2014).

The primary condition of the foundation of a hub is defining the priorities, objectives, strategies for development to begin with a powerful establishment that fits in the regional economic realities. While a fundamental aspect of it appears as lifelong learning formed around higher education vision, hubs can be categorized with respect to the activities and purpose: **student hub, skilled workforce hub, and knowledge/innovation hub** (Knight, 2011). Mitchell and Watstein (2016) argue that in an environment with the concept of a learning hub, many different functions can cooperate:

- ✓ A factory of newly emerging idea horizons and consistent creative acts.
- ✓ Student-centered learning ecosystem highly supported and characterized by collaborative research and applied activities-based experience.
- ✓ An organizational structure where constant counseling of expertise and experience arouses among actors.
- ✓ The emergence of an intellectual character defining a community composed of all academic elements that can benefit from it, with a powerful aspiration to achieve specific goals (Mitchell & Watstein, 2016).

Off-Campus Hub Cases

1. Good School (Hamburg GERMANY) 2009 by Simone Ashoff: Good School serves as the most influential cybernated center of data and information trade in Hamburg. While having coached many domestic and also globally known specialists in the digital marketing and IT area, this organization provides invaluable instruction to its partners through them. What is more, a sentimentally retro-style was chosen for the interior design that displays high technology items and original ideas even in simple workshop spaces. Collective sharing, communication, and continuous learning regardless of age or status prevail as the governing values. For that reason, any event takes place here from live gigs to digital media hackathons as long as it is contributing to the common purpose.

2. The Hub Rovereto (Rovereto ITALY) 2011: A workspace that's shared by entrepreneurs from a variety of fields. It is also a part of a social enterprise that spans 25 cities around the world, providing work spaces, facilities and connections within the network. One feature that unfolded was the strong focus on making people the center of the physical space. Visitors and members are guided into the space by evocative phrases written on the perimeter walls. Furniture and space design plays a critical (underlying) role in determining how people behave and can have a hugely positive effect on encouraging collaboration. The architect created modular tables to provide flexibility for a variety activities. They can easily be moved to create a larger conference room or a projection area or worked on as individual desks. Imagination and pioneering drive have been the golden rules of the design traits of this uncommon place, also called a company of discovery and an agency of collective brainstorming. As their motto explains itself *''people do not need walls, rather gates to connect ''*, the interior arrangements propose the flow of fittings and movable furniture supporting the highly collaborative interaction of agents. This sort of organization naturally suggests the freedom of appropriate modifications whenever needed for distinct purposes. In addition to that, The Hub aims to radically spearhead the entrepreneurial sustainability for the better of the globe as an incubator center, and besides provides consultation services to accelerate the launching of innovative ideas as socially and environmentally impactful initiatives. It promises its partners a unique experience amidst a skillful network, inspiration to take action and the technological tools they would need during all the intermediate steps from the draft into reality (Rajaei, 2011).

Figure 4-5. Rovereto Hub, collaborative working space (Rajaei, 2011)

Figure 4-6. Rovereto Hub, group meeting space (Rajaei, 2011)

4.4. Institutional community

Community, meaning ''public spirit'', addresses a social unit with commonality such as values, customs, or identity. Members of a community may share a sense of place situated in a given geographical area (a village or neighbourhood) or in virtual space through communication platforms. Community development is often linked with alliance work that may involve various stakeholders to progress the social well-being of local and national communities. Specialists in community development and planning investigate both how to work with individuals and how to affect communities' positions within the context of larger social institutions. In the UK's Oxford University, an extensive research in the field has been submitted through its worldwide recognized *Community Development Journal.* As a subject of high complexity, universities usually incorporate all community types such as location-based, identity-based, organization-based and imagined (idea-based) (Community, 2019).

4.4.1. Physical setting for a commune culture

Tertiary education and its setting are an inseparable context in a complex campus (Coulson et al., 2014). Every campus comes with a unique cultural character through decades of evolution until today which is demonstrated in its system of values and ambiance, the common working model and institutional structure. This blend manifests itself in the physicality of the campus as well (Hebbert, 2018). However, there is a rather latent reasoning to that: The sense of identity linked to the buildings and landscapes by higher education community. Acker and Miller (2005) assert that in campus places, the meaning attributed to informal spaces by students and academics have an impact upon casual social interaction. The unforgotten parts of campus facilities, for instance, transition corridors and connective halls may be transformed into informal gathering spots. According to student evaluation results, features of informal places have consistently been mentioned such as high flexibility, connection to the web, easy access to food, ergonomy for either solitary or co-operational work. Therefore, re-imagination of the institutional character emanates with physical changes, and the community in return responds to it (AIA, 2006). A recognition of campus as a whole, before perceiving it a collection of specialized faculties can alleviate the sense of community (Rytkönen et al., 2017). The solution is creating a functional or a student-friendly landmark that validates common values (AIA, 2006; Coulson et al., 2014).

The change in organizational culture can be pioneered by a process of three stages, that could be practiced within a blend of disciplines. The first stage is consolidating dedication based on common values, external motivators, learning experience and network building. The second is visible support and devotion of the administration team. The last and third stage stipulates further supportive tools such as awarding system within interdisciplinary activities or creation of fitting spatial arrangements (Kezar, 2005; Lavy, 2008). Similarly, Friedman and Worden (2016) note three equally fundamental aspects of a space: location, material form, and meaningfulness. A general framework was developed to experiment with different configurations in diverse campus spaces dedicated to interdisciplinary work.
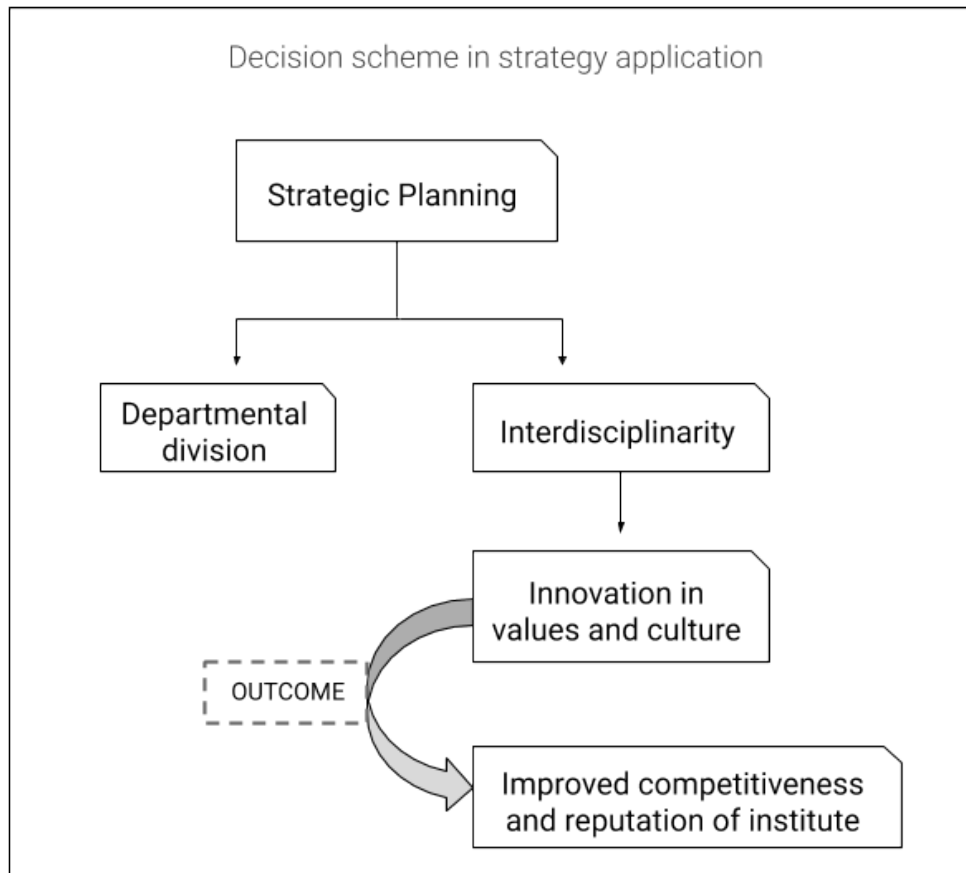
Figure4-7. Strategic planning on interdisciplinary decision-making mechanism in higher education institutes (Feller, 2002)

Schewenius et al. (2017) underscore that the new resilience paradigm takes shape around sustainable development, which calls for an inclusive design process, harnessing inevitable change and fostering diversity. This way, the adaptive capacity of economies and societiesare increased to meet both the present and near-future needs.
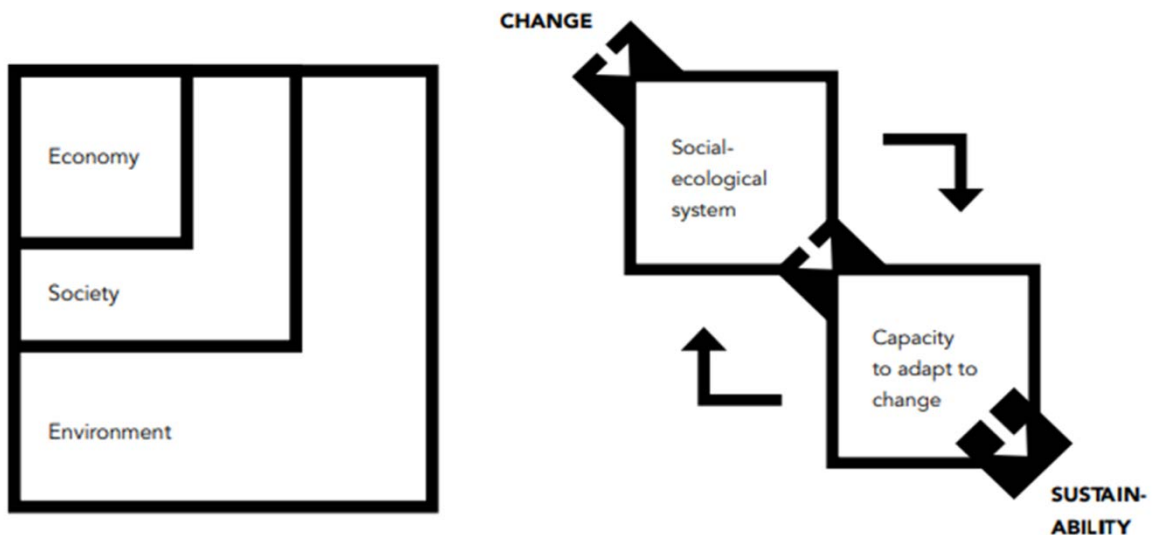
Figure 4-8. The three nested systems of sustainability: In the scheme on the left, the economy wholly contained by society, which is wholly contained by the biophysical environment. On the right, a social-ecological system presents a resilient adaptation when change conditions emerge, i.e. its capacity to adapt to change and shape it in productive ways. Rather than the resilience, which is a method for dealing with change, sustainability should be viewed as a process instead of an end-product (Schewenius et al., 2017).

Many scholars commended to understand the attributes of organizational change. The broadly followed method is the implementation of an *incremental change* process. This hints at a prolongation of earlier established norms and parameters in the institutional culture, that are rather ineffective. On the other hand, *transformative change* remarks interruption of the built-in standards, breaking old norms and values, and instead demanding a new system of skills and knowledge per se. The critical point of the path leading to a change is accepting the immediate reaction to change: perceiving it *a threat to habitual values and setting*. A strategical treatment of this reality by correct leadership would define the success level of the attempt to change. A model should be introduced in early on, despite resistance, in order to establish a pre-justification for people who will experience the change immediately (Imms et al., 2016).
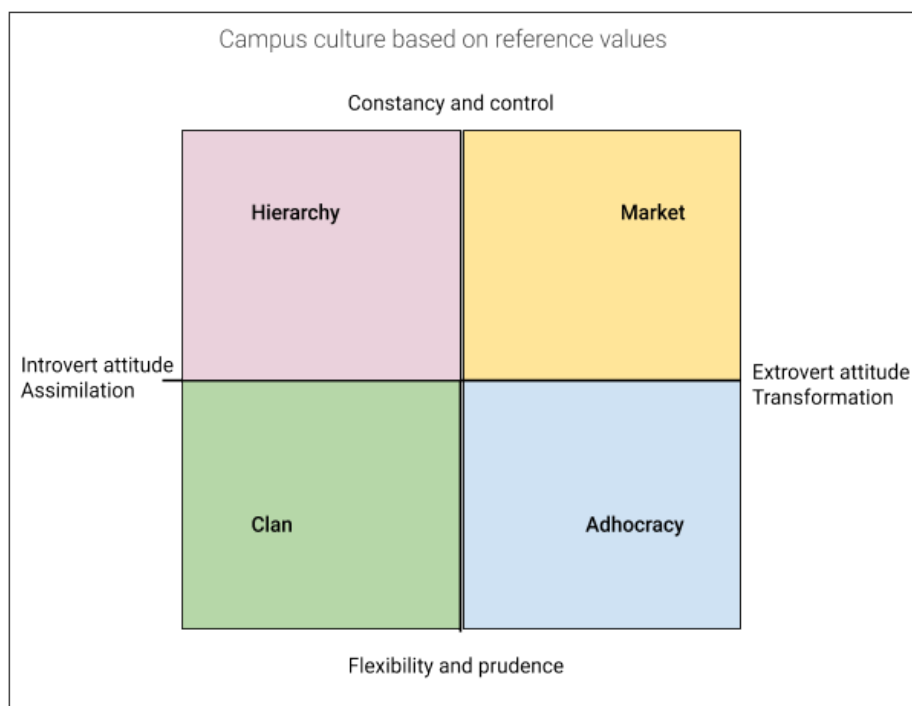
Figure 4-9. Possible suits of opposing norms that can be adopted by a university community (Feller, 2002).

The prevailing features of different institutional culture phenomena			
Clan	**Adhocracy**	**Hierarchy**	**Market**
-sociable and welcoming working ecosystem -supervisors as parental leaders -culture of trust and tradition -engagement by collaboration, fair distribution of benefits and commonly consented social rules -success lies in the care and participative decision making in this culture	-interactive place that liberates the creativity of minds -leaders adopt a pioneering approach, are risk-welcoming -commitment through innovation and prototyping the ideas -development towards cutting-edge novelty -success measure is the originality and uniqueness of the output	-place of a strict power structure with formal roles, the governor makes the rules, coordinates the inferiors and the processes -the optimal scheduling and the highest profit with lowest expenses make the core of the culture -commitment achieved through employee security -success measure is the efficiency rate of all the operations	-driven by the achievement of tasks and outcome centred, culture of competition and productivity -leaders demand a lot, put people in pressure to win and achieve more profit and brand recognition -commitment is ensured by striving for new goals and increased ambition for higher reputation -success measure is obtaining the most shares and market domination

Table 4-2. Core principles that establish each given community culture above in an educational institute (Feller, 2002)

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4.4.2. Stagewise implementation

The lack of a systematic attitude toward a modified campus culture abolishes the chances of uttermost efficiency and expected impact in the application of plans and practices. From the point of management and financing, an equilibrium between maintenance and innovation is a key solution for a successful campus modernization project that stands for the collective ambitions of its members (Klein, 2010).

Reflection on decisions made in higher education institutes has to go through an altering process as the interest in boundary-crossing knowledge increases. The prevailing institutional culture modifies itself over time with implementations and outcomes. Purposeful action plans are the key elements of a successful culture-shifting process, along with the financial supporters (Holley, 2009). For instance, social interactions and critical conversations also significantly stimulate the transformation in a collective working system (Moradi & Wiberg, 2017). Regarding this statement, aspiration for communicative capability within cultural coexistence can be pursued in three degrees of affiliation: on the individual, shared and collective level. By these means, higher-order learning applies more successfully through one's own experience, interpretive pondering, and synergic discussion (Bruton & Pavitcha, 2018). Therefore by looking at the big picture, the act of change is undoubtedly carried on by effective collaborative activities among specialists from different fields. The managing body of the institution shall come to a consensus with the community itself which is the main subject to the upcoming change in their habitat. Thus, creating a common base of understanding among related partakers is vital. An advised method to give a start to a transformation in learning environments follows these steps:

a. Evaluation of what is in hand, the decision of what to keep and what to discard.
b. Conceptualization and simulations of the foreseen design of a space.
c. Anticipated effectiveness of the concept in contrast to specified needs.
d. POE based on the reference guidelines (Imms et al., 2016).

A method for improvement in designing collaborative environments that had been framed for the incorporate setting is tested in the context of higher education (*Figure 2*). First comes the task of redefining the missions and then methods of actualization in compliance with those. This is followed by the introduction of updates in organizational operations and educative principles toward a collaborative environment containing different departments. The last step comes as the sustaining actions of these changes by performance evaluation in goal setting and achievement based on newly founded principles. Each step represents a crossroad in the whole process as they require repetitive interpersonal contact in collective activities while collaborating and negotiating for shared goals (Kezar, 2005).
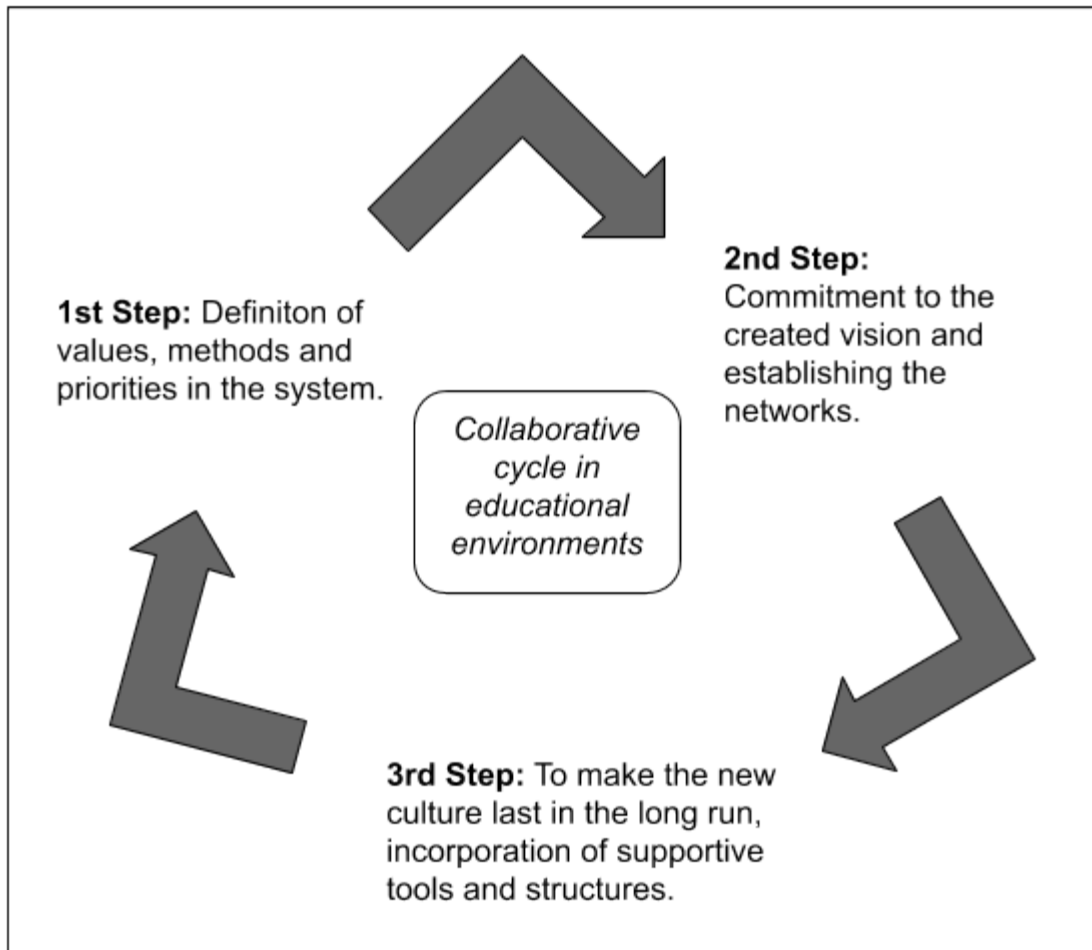
Figure 4-10. Sustainability model for collaborative higher education by stages (Kezar, 2005)

4.5. Power structure

Rytkönen et al. (2015) uncovered that a vertical model of power structure remains an adversity among academics. Beginning with the overall power structure in administration, a flexible network of relationships and adhoc positions that leverage the operations to increase an institute's competitiveness. On top of that, the experimental spirit of the place compels interdisciplinary environments of connected members (Feller, 2002).

In an example, the campus culture concept is explicated on two axes, vertical axis representing the autonomy level on inner goal setting while the horizontal illustrates the freedom of self-government on an individual scale. The type of university culture described as 'oasis' is identified with internal freedom and autonomy, which decidedly associates all internal actors as colleagues -except the administration and wider public act (Figure xxx).
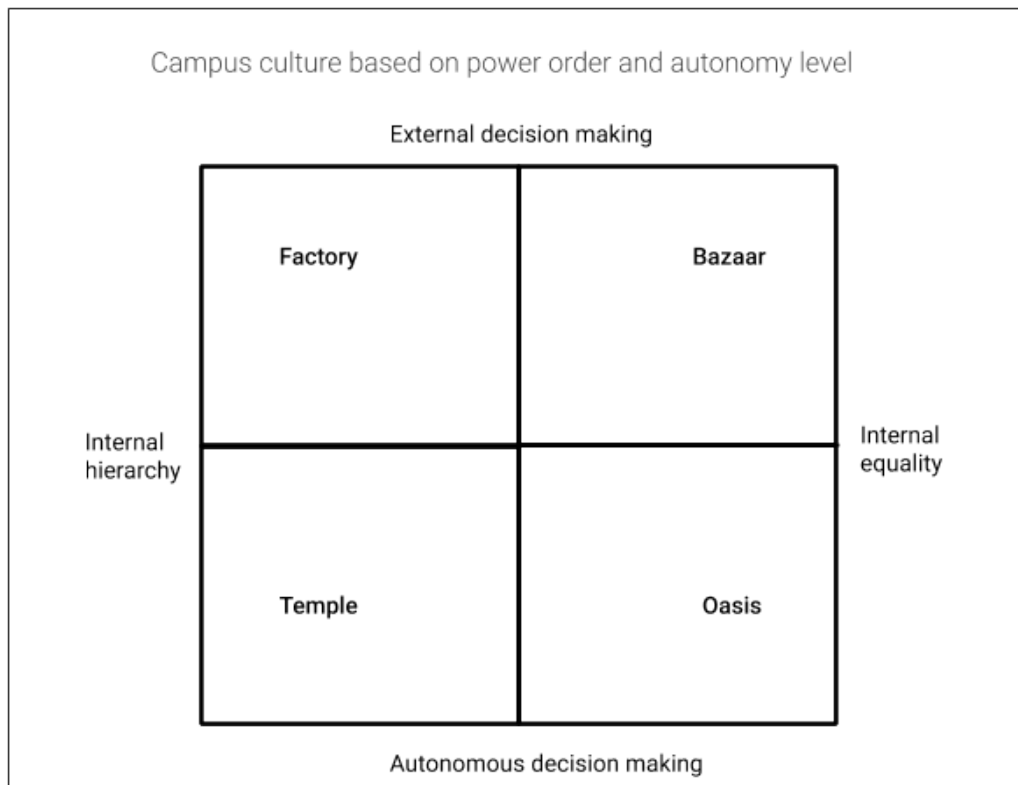
Figure4-11. Four university cultures, based on autonomy level and internal power order (Tapio et al., 2011)

Networking transmits a common ideology constantly across the campus territory for a homogeneous developing. Hereby the rigid authority structure weakens the fair means of control and decision making, which results in a sense of community over time (Kezar, 2005). The oasis culture dissolves the habitual hierarchy structure in university allowing a shift towards an enhanced fair play. Members in the academic community are all equalized, in an environment of constant investigation and critical questioning. The competent aspect of this model is the generation of innovative conceptions that is likely to develop the desired interdisciplinary mentality; when in fact bringing out the risk of losing the connection with real-world problems endured by society (Tapio et al., 2011).

Table 4-3: Actor roles and information flow between them across different campus cultures (Tapio et al., 2011)

Stakeholder roles in various higher education institute cultures

	University Culture			
Internal Actors	**Temple**	**Oasis**	**Factory**	**Bazaar**
Teachers	bishop	colleague	controller	manager
Researchers	priest	colleague	labor	entrepreneur
Student	congregant	colleague	raw material	client
Other employee	verger	colleague	service staff	facilitator
External Actors				
Government	patron saint	patron	investor	client
Private partner	tax payer	tax payer	consumer	client
Community	pagan	audience	consumer	consumer

5. Facility Management Solutions

The Facility Management discipline was born in the United States in the early 1980s during times of a difficult global economic and financial fluctuation; local companies had to confront a market that had fundamentally changed its characteristics almost instantly. It fairly presented a domino effect: geographical barriers became less rigid for the trading of goods, the emergence of more varied options induced greater freedom and a wider choice compared to the earlier times, the altering consumer needs essentially changed the supplier and customer commerce. The enterprise overgrowth compelled development of the tools to manage the complexity. One of the main strategies became the identification of the service value for the businesses and their management (IFMA, February, 2020).

In consideration with the development process over three decades, International Facility Management Association asserts the core of this practice as "A profession that encompasses multiple disciplines to ensure functionality of the built environment by integrating people, place, process and technology". The services necessary to support an organization's business are identified and applied in the design and control process through which the facilities provide the optimal level of service capable of meeting business needs, creating a quality work environment with as little expenditure as possible. In other words, Facility Management coordinates the physical spaces with human resources and the company's own activity while incorporating the principles of financial management, architecture and behavioral and engineering sciences (IFMA, February, 2020). Regarding these principles, the evolving perception in the utility of a space can be achieved by an effectual facility management approach, which takes on the duty of balancing out the accumulated change in societal values and technological applications for the sustainable and interdisciplinary existence of campus facilities (Haggans, 2015). The research directed by Lindvig, Lyall and Meagher (2019) affirms that creating interdisciplinary education obligates skills on *'the art of managing the institutional changeover',* since these universities have to undergo a transformation to sustain interdisciplinary infrastructures.

5.1. Facility management in higher education context

Coulson et al. (2014) report that facility management (FM) activities on campuses are responsible for well-scheduled and well-priced support. The compound nature of FM exerts a practical tool that intervenes ideally in the twofold character of educational facilities, which comprises of the human factors and the institutional performance (Amaratunga & Baldry, 2000). The utility results verified positive contributions to user satisfaction in higher education facilities. However, the capability of answering the immediate needs for flexible educational environment the execution of activities is still to be achieved (Kärnä & Julin, 2015).

Design and management strategies in higher education institutes should reevaluate the community interests. Initiatives for broadening interdisciplinarity in higher education have

been discouraged in the US according to the research, since it was not properly promoted in the academic environments and seen an 'unworthy expense' for the campus (Spelt et al., 2009). The underlying issues should be solved through guiding questions on how to imply the most added value:

- In which aspects and to what extent can this educational setting can approach an excellent level when facility management practices are massively integrated?

- What could be the position of a facility manager in the campus administration regarding the previously introduced scenario?

- Which attitudes could be redefined for the academic associates and other active users on the campus to leverage and promote the new facility services the best? (Kok, Mobach & Omta, 2011).

The typical premise in today's FM service assumes institute administration the key client. However, it is suggested that the real key client could be the campus users. For instance, in the planning stage of a mixed-use learning center has to consult the future user's opinion first (Ahmadi et al., 2016). Well-functioning management on campuses happens at the intersection of student aspirations and managery concerns of the campus administration. If students are perceived as a collective investment, this could be a driving factor in the development of management procedures. The following scheme demonstrates the interaction between the governing principles (motivation, approach, budget, value-added) and the campus spaces, both physical and virtual (Figure xx.) (Rytkönen et al., 2017).

The steps for a transformation should be engrained in the operations of the institute, in the beginning limited to a seed budget and observation of the immediate outcomes. Then evaluation and decision making based on usefulness and efficiency must follow. In this regard, campus management has to develop strategies accentuating the significance in interdisciplinary community on institute-wide participation (Rytkönen et al., 2017). Influential FM and project management strategies are employed right from the start: active presence of every kind of stakeholder, from designer to future user, is ensured with a constant flow of opinions and expression of neglected needs. How to embody these in facilities design and planning, crucial details in spatial organization and effective execution by virtue of technical and infrastructural elements have to be revised (Neuman et al., 2013).

5.2. Administrative power

Universities constitute a composite of formidable features that become very demanding to supervise coherently in the account of the dispersed authority across campus units that undermines a stable and reliable administrative power. The decisive hierarchy remains interrupted and ineffective, given the interjacent bureaucracy, and impacts on all the scholastic course of activities within the campus. Ultimately, the competitiveness in the education industry induced an authoritative compulsion to perform assessments both on the

quality of the educational activities and also the responsibilities a higher education environment bears as a service to society. And the involvement of third-parties for evaluative inspection marked a serious improvement regarding the university management tools (Enders, 2015). With respect to the findings of a research, Rytkönen et al. (2015) suggest a bottom-up approach that is based on action, limited budgets and quick results for early feedback, which promotes a communal space as an expression of fused physical, virtual, mental scales. They further address to an augmenting complexity of managing the processes in organization-wide changes and facilitating added values that call for a special treatment, particularly in universities.
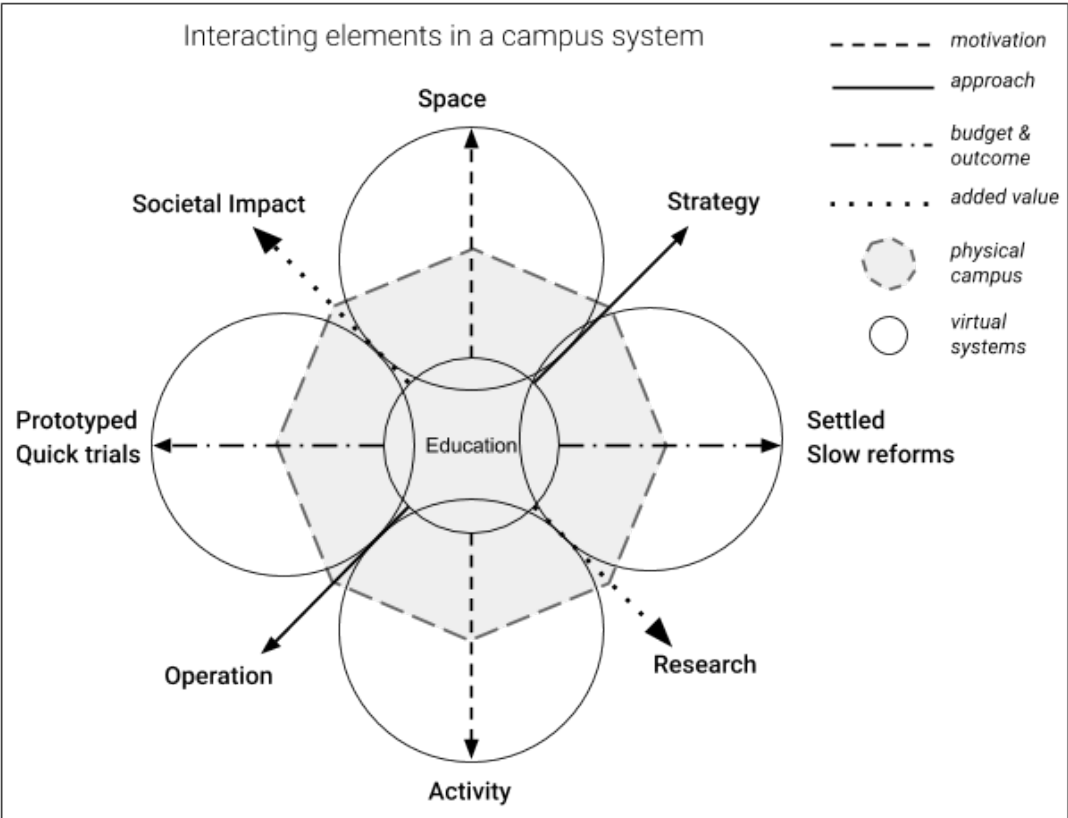
Figure5- 4. Interrelated campus management variables. A five-dimensional model was created, on each different needs of the internal and external community being tested on relevant scales with opposing two ends of diversified objectives (Rytkönen et al., 2017).

5.3. Sustainability

The improved energy conservation in educational facilities extend beyond solely environmentally sustainable operation strategies, but it is equivalently determined by the patterns of building occupation. Based on the study administered on the energy output data simultaneously in two different university campuses in California for 36 months, the conductors proposed there would be a firm correlation between sustainable energy consumption and the effectiveness of the facility utilization assessment. The outcomes

affirmed that a noteworthy energy saving achieved by strategic management of the facility operations and planning of the learning activities. It was highlighted that more recognition should be given to the planning of sustainable standards of a campus in alliance with the academic life happening in the buildings (Petratos & Damaskou, 2015).

5.4. Key characteristics of campus environments

Studies illustrated three strongest arguments in establishing technical proficiency and infrastructural support in unique university spaces (Imms et al., 2016). A guideline to maintain beneficial standards in environmental design was developed, which derived from numerous factors such as sociability, ergonomy and psychology – justified by facts such as territorial-local attachment, privacy, and user autonomy (Berthelsen, Muhonen & Toivanen, 2018). In correspondence, Taylor et al. (2009) advocated for a complete learning experience, that the human actors and the materialistic elements shall be in harmony for the most successful outcomes. This affiliation steered to questions at deeper level in higher education facilities. What physical facility conditions would support the best welfare? What kind of design approach would improve cognitive learning of diverse styles? What spatial features or elements make users feel motivated or joyful? The multidisciplinary contribution from both architects and education specialists are presented in two vital components of the learning activity and the most critical aspects of each for a fair development of a holistic education facility (Taylor, Enggass & Pressman, 2009).

Table 5-1. The basic aspects of designing facilities with respect to learner's and facility's wholeness (Taylor et al., 2009)

Holistic vision for education facilities design	
The integral learner	**The integral facility**
Body: *physical aspect*	**Firmness:** *structure*
Mind: *cognitive aspect*	**Commodity:** *function*
Spirit: *emotion aspect*	**Delight:** *beauty*

Thus, planning or refurbishment works in an environment provided by educational facilities are encouraged to proceed through this agenda of five specifications stated in the following:

1. Aesthetics and philosophy.

2. Institutional strategy for planning and implementation.

3. Lessons learnt from multi-perspective environmental studies.

4. Futuristic thinking.

5. Establishment of trust between human, society and ecology (Taylor et al., 2009).

For a thorough understanding of the chief characteristics of modern educational spaces, *Learning Landscapes* applies an approach that illustrates a set of qualities. Spaces are differentiated or blended into each other based on the desired level of *specificity and informality*. **Figure5-2** elucidates the exploration of the shifting characters in learning spaces. The mapping tool displays present informal learning spaces, to guide the design of the new facilities with awareness and respond to neglected needs; which empowers planning of the user experience over the planning of the building masterplans first (Neuman et al., 2013).
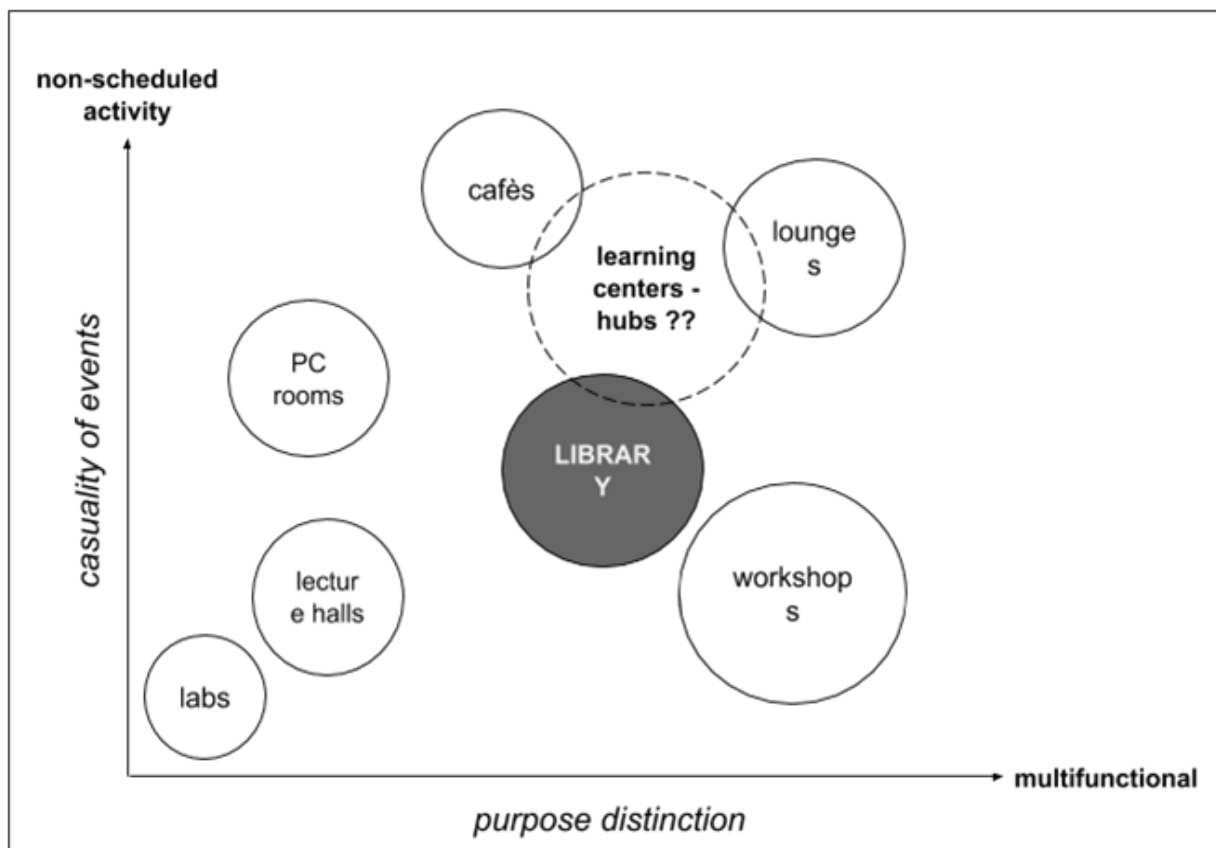
Figure 5- 5: Definition of higher education spaces in the degree of formality and flexibility of target purposes (Neuman et al., 2013)

The recent alterations require adaptations in planning procedures, and an appropriate correspondence when managing the interrelations between time, users and processes (Rytkönen et al., 2015). Spatial design that complies with the high-impact digitized (r)evolution elicits substantial savings in the management of learning environment. Table 2. draws an impression on two fundamental elements of a facility, the users and the spaces, in relation to adaptation of new attitudes and flexibility of faculty spaces in the face of an institution-wide change (Rytkönen et al., 2015; Imms et al., 2016, p.44).

Table 5-2. Flows of supportive intangible sources to lay a ground for encouraged collaboration and interdisicplinary framework in an educational organization (Rytkönen et al., 2015)

	Change in social characteristics	Change in material structures
Skill flow	Institution members need to develop an understanding of adapting themselves in an interdisciplinary context rather than concentrating on single and specialized disciplines.	Too formal and single discipline oriented workstations and departments must be converted in multipurpose spaces.
Information flow	The method of instruction evolves into a learner oriented one, putting the conventional teacher-centred education aside.	Digital installations and technology devices allow the disciplinary and activity-linked restrictions for a place to soften, increasing the possibility of educational interaction.

A mismatch between availability of space and steadily increasing student numbers cause a competitive stress in university environments. For instance, the case of exclusive rights given to departmental users for space utilization hinder others to make us of those spaces unreasonably. In advance room-booking system and desk claiming by users as well adversely affected the accuracy on the estimated availability. In the Netherlands, a group of higher education directors carried out an inquiry of smart tool integration of space management to measure and compare the results to the previous findings. Favourable outcomes concluded the inquiry, stating that it was simpler for students to spot availability with the tool, regardless of department or activity type (Valks, Arkestejin, Heijer & Putte, 2018).

5.4.1. Managing the spatial change

In order to explore how the interactions of space, technology and people alter each other, spatial transformation theory defines space as "the material support of timesharing social practices". Space is not static but, rather, it is constituted by social relations, technological, political, social and economic forces, and transformed along with them (Figure 4). The concept of space is thus shifting from being a static space of places towards a dynamic, interconnected space of flows. The space of flows is an infrastructure that connects functional nodes that operate in real time, independent of geographical locations. The role of the nodes in the network are to an increasing extent determined by their functions, not locations (Rytkönen, 2016).
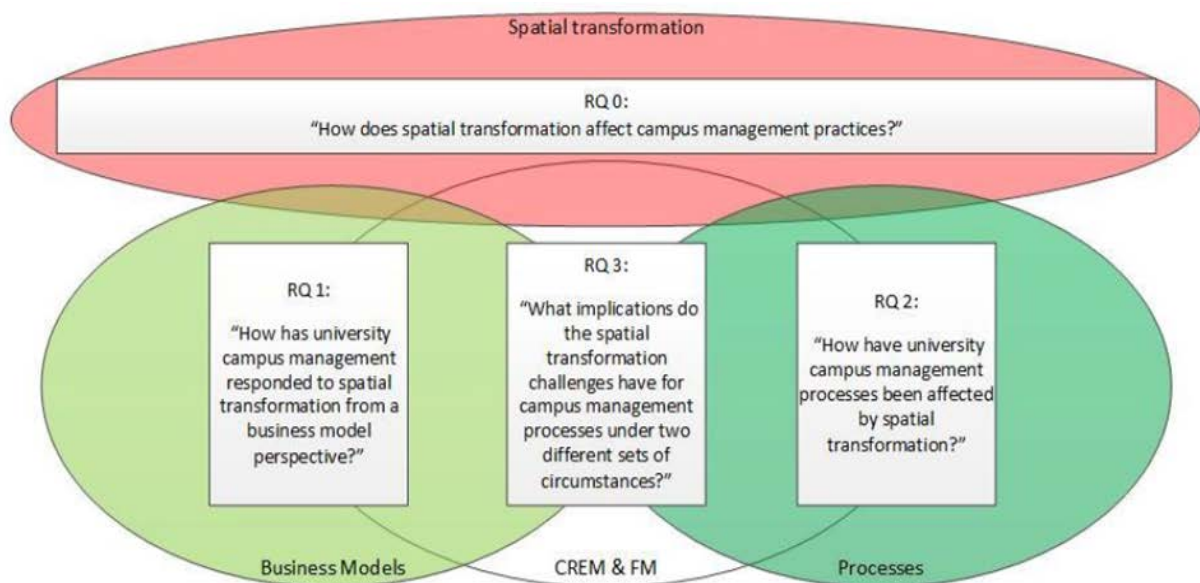
Figure 5-3. The research questions employed in the study which investigates 'how spatial transformation affects university campus management (Rytkönen, 2016)

Rytkönen (2016) explains that this conceptual study was to investigate how effectively a business modelling tool called the *Business Model Canvas* (BMS) could contribute to campus management. Essentially, the balanced scorecard (BSC method) approach of corporate real estate management (CREM) is compared with the results obtained from the BMS. The findings suggest that the business model approach has the potential to accurately uncover the demands in the changing campus landscape. Ultimately, BMS was acknowledged a constructive tool for conceptualizing, visualizing and discussing the key points of the cases.
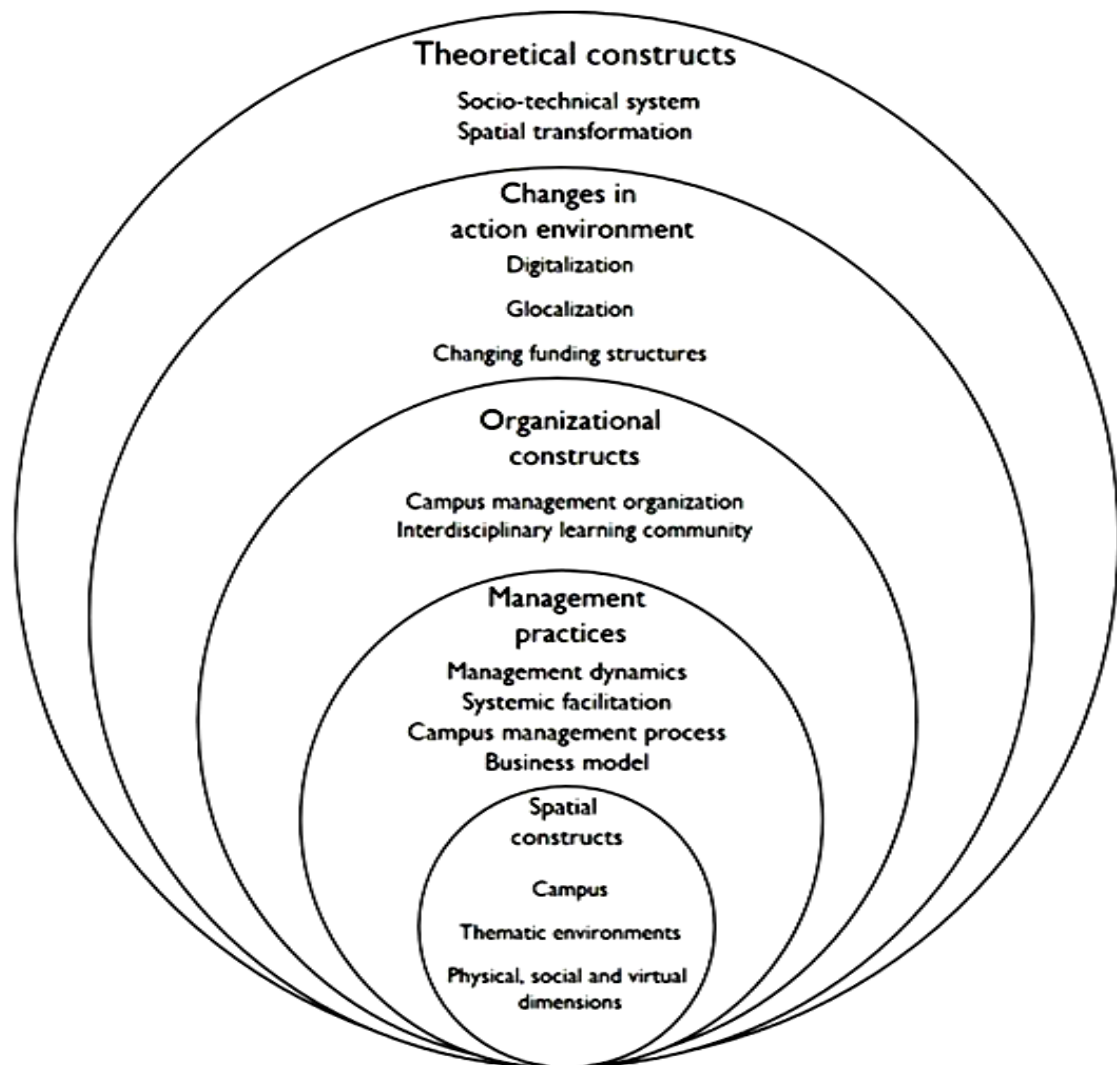
Figure 5-4. A theory of the power order in a transforming campus environment (Rytkönen, 2016)

Business model: a firm-centric construct that attempts to map the entity of interconnections and tackle the issues of an organization creating, delivering, and capturing value in an interconnected, multidimensional business environment.

Glocalization: to products or services that are designed to benefit a local market which are at the same time being developed and distributed on a global level.

Management process: the process of setting goals, planning, organizing and leading the execution of a project or a process.

Spatial transformation: a socio-technical phenomenon that takes place in the network society. It modifies the concept of space and can be identified through changes in dimensions of Form, Function and Meaning.

Thematic environments: the spaces and places that are built around themes rather than disciplines (Rytkönen, 2016).

5.4.2. Campus staff

For effective operation on campus, regular appraisals of responsible staff has to be ensured. Further training of technical staff and teaching personnel should be arranged at intervals to strengthen the successful implementation of educational performance. Teachers within this environment seen as the key actors leading the interdiscipinary approach (Darling-Hammond, 2009). For example, formative assessment can play a key role in fostering deeper learning and the development of 21st century competences. However, most teachers are not familiar with the lastest pedagogical novelties, thus, do not incorporate those in their teaching practice (Pellegrino & Hilton, 2012, p.5). A specific guide concerning post-occupancy evaluation (POE) report and toolkit was published in the UK in 2006 by Association of University Directors of Estates (AUDE). The guide targets professional formation of the higher education staff members and other specialist employees in modernized pedagoy, with the purpose of setting more accurate standards within education institutes for each phase of the facility (Riley, Kokkarinen & Pitt, 2010).

5.4.3. The built property conflict

Long-existing educational facilities evidence a more demanding task for facility managers to formulate suitable solutions in conformity with modern society and technology. Additionally, constantly increasing maintenance expenditures during the building's lifetime. A course project developed by the students provided an insight to the theme. The analysis refers to the life cycle costs (LCC) of an engineering faculty building with five floors that are occupied by the lecture rooms and laboratories. The estimations reveal that the maintenance and renewal costs of the building, excluding the energy consumption expenditure, make the 83.0 percent of the total LCC, while only 17.0 percent is calculated as the construction cost. The results uncover an important impression for stakeholders of a built asset to realistically subsidize a project at the beginning with all its preservation and maintenance costs throughout the expected building lifetime (Petratos & Damaskou, 2015). The active use of building portfolios and material resources should be a reinforcement of student experience. These environments are considered depletable assets, requiring a constant assessment on emerging needs and problematic areas (Vidalakis, Sun & Papa, 2013). Neary et al. (2010) evidence that fixed built properties prevent the flexibility- especially the single-use units. For this reason, a combined asset portfolio is suggested of such qualities:

- *Core space*, intended for unique purposes and expressed demand, constitutes the identity and message.
- *Flexi-space*, transitory places for short term events or collaborative actions.
- *'Just in time' space*, temporarily used only in emerging needs for back up. This particular kind of space is pointed out to give a flexible decision area in terms of financial and material risks.

Partnerships in joint ventures has been recently embraced by university managers to add flexibility in institutional real estate management (Coulson et al., 2014). Shared properties with multiple enterprises, leased or divided upon agreement among allies, empower interaction between different groups and attenuate the heavy expenses of advanced equipment for a university's financial resources. Besides, it increases the adaptability in properties against future needs. Revision of the built properties is a sustainable solution in the following order, specifically for universities with constricted space availability:

1. Detailed inspection of the campus site.
2. Settling the organizational vision and ideals, accordingly diagnosing occasions for renovation works.
3. Programing of campus management operations and execution schemes for different time-frames in the future (Coulson et al., 2014).

5.4.4. Planning and efficiency

As a living ecosystem, campus environments are characterized by a fourth dimension in addition to the built environment: planning. To achieve an efficient interdependency between campus units, the complexity of spaces must be well understood. Both adjustable and immovable design elements have to be ideally incorporated, otherwise disorder and wastefulness take over, as observed on 20th-century university campuses (Neuman et al., 2013). Tactical planning by university administration indicates to readiness to adaptat due to the interdisciplinary shift in higher education environments (Feller, 2002). Besides, modern organizations are enforced to consider the environmental issues with a growing sense of responsibility. Therefore, the technologies that contol the energy consumption and resource savings of the built properties have been widely adopted. Petratos & Damaskou (2015) recommends that planning elements include considerate scheduling of the activities and entrance allowances to optimize the building utilization levels, prioritizing the availability of adjacent spaces, then accordingly modifying the energy supply allowed to each facility.

Operational effectiveness in buildings have particularly advanced in northern countries and Australia, which reveals a long-sighted consideration of future demands on campuses. Facility management increased its impact in methodological assessment of built properties, as complexity of systems and interconnectedness climbed up drastically (Eley, 2001). As an exemplary case, the LEaRN section at the University of Melbourne claimed that learning spaces have a mission of providing a set of multiple tools and fulfilling certain environmental conditions for all groups of users. The ex post facto of the research handled with this idea showed that an assessment work must be carried out with a clear purpose in the first place. Usually, the driving force proves to be value determination or a radical decision making step for the institute (Imms et al., 2016).

5.4.5. Application errors

There is a lack of inquired understanding in how campuses can successfully run a development process in employment of interdisciplinarity. None of the recognized techniques completely respond to efforts in spatial transformation, nor how to perform the process of institutional change toward interdisciplinarity with coherence (Rytkönen et al., 2015). Identification of the best practices, then handing these sources down to diverse agents of the institute was caimed an insufficient initiative (Henderson, Beach & Finkelstein, 2011). A case study that elucidates the failure to comply with this code was reported by the project in UK in 2012 by (QAA) Quality Assurance Agency, covering sixteen HE institutions across the country. The outcomes illuminated the student displease for not transparently knowing whether the value of provided services compensate for the fee they pay. A second disappointment was detected in professional guidance services of the universities since this constitutes a critical importance for future employment (Kandiko & Mawer, 2013).

It is claimed that rather than insufficient collective support to change, the methodical planning and execution to promote interdisciplinary work is the inadequacy. How to change the entrenched patterns or their connotations invoked upon people, lies in the strategic policy change (Sa, 2008). Franks et al. (2007) summarize the primary factors that impede the consolidation of an interdisciplinary culture; such as, creating disciplinary and social proximity among the campus members.

Table 5-3. Barriers to interdisciplinary in different literature (Franks et al., 2007)

Resource	Barriers to interdisciplinarity according to different resources
Braddock et al. (1994)	- Long-established barriers between disciplinary sections. - Social or relative proximity hurdles. - Prejudice and conservative approach of members towards evolving institutional change and blurred department boundaries.
Bradbeer (1999)	- Variations in methods and pedagogy in different study fields. - The nature of different knowledge domains may not correspond easily. - Diversifications in academic personal's research culture and teaching styles.
Brewer (1999)	- Different standards of decision and conclusion. - Clash of methodologies and missions between disciplines. - Disconnection of disciplinary languages.
Fry (2004)	- Individual struggles, such as reputation and respect among the co-workers. - Managerial setbacks like funding and resources distribution. - Diversity of heavy terminology of some disciplines. - Promotion, status and peer review mechanism impeding interdisciplinary collaborations.

5.5. Evaluation and assessment tools

Concerning varying requests imposed to the higher education industry, which represent different groups of relevant actors, total quality management (TQM) was suggested as an auditing technique, which originated in the US several decades ago. The complete procedure effectively denotes the reciprocal dependence for the infiltration of the most effective success measures within a simplified bureaucracy. On the other hand, the Kanji model (Fig.x) has been associated with the education industry that proposes a powerful management program, which is originally a business model. Fundamental elements are given as customer pleasure, continuous progress, and rational decision making (Kanji, Malek & Tambi, 1999).
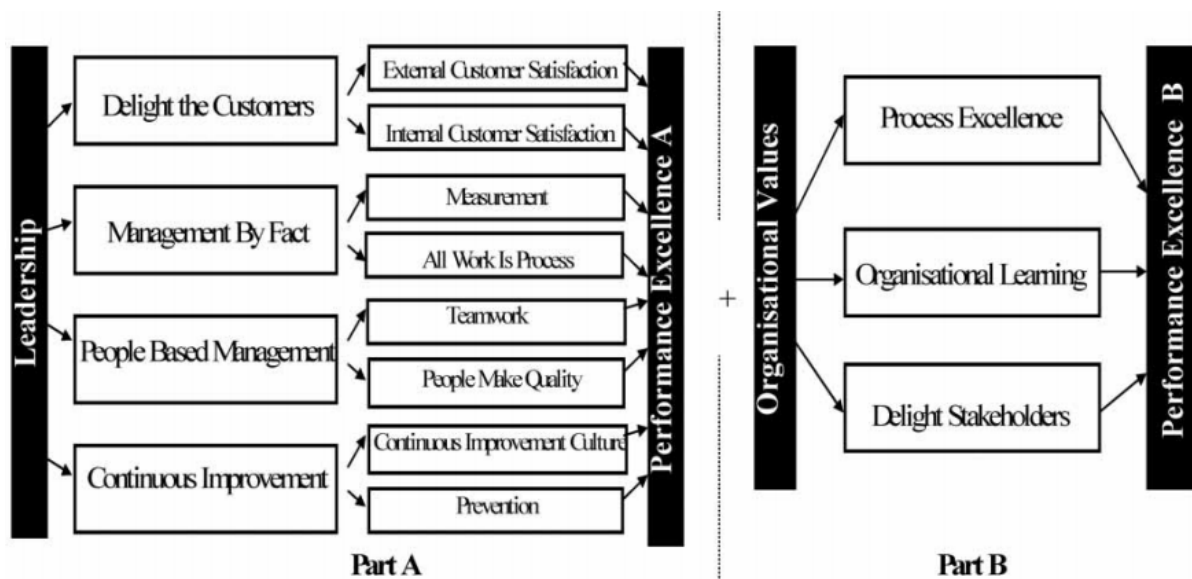
Figure 6-5. Kanji's Business Excellence Measurement System (Kanji & Moura Sa, 2007, p.53).

For the performance improvement in HE institutes remaining in constant request, guiding standards are in continuous progress. On top of that, a special indicator called 'sense of community index'(SCI) has been presented for further success in socially complex subjects at an organizational level (Dawson, Burnett & O'Donohue, 2006). Having clearly and intelligently prescribed benchmarks to maintain an elevated quality in methods and environments where education takes place is a significant factor of this success (Darling-Hammond, 2009). The clash of interest between disciplines causes this too. As FM experts and architects and planners are keen to gather different kind of information from an inquiry, the data is eventually perceived impossible to seize. For instance, technical performance measures and functionality of spaces do not correspond in a single evaluation technique (Ahmadi et al., 2016). For instance, the EduTool- IEQ has been developed as an evaluative instrument, scoring the performance with respect to 16 features that possibly have the biggest influence on educational activities. It is considered to be unique and effectively easy to interpret the data thanks to its visual design of data communication (Imms et al., 2016).
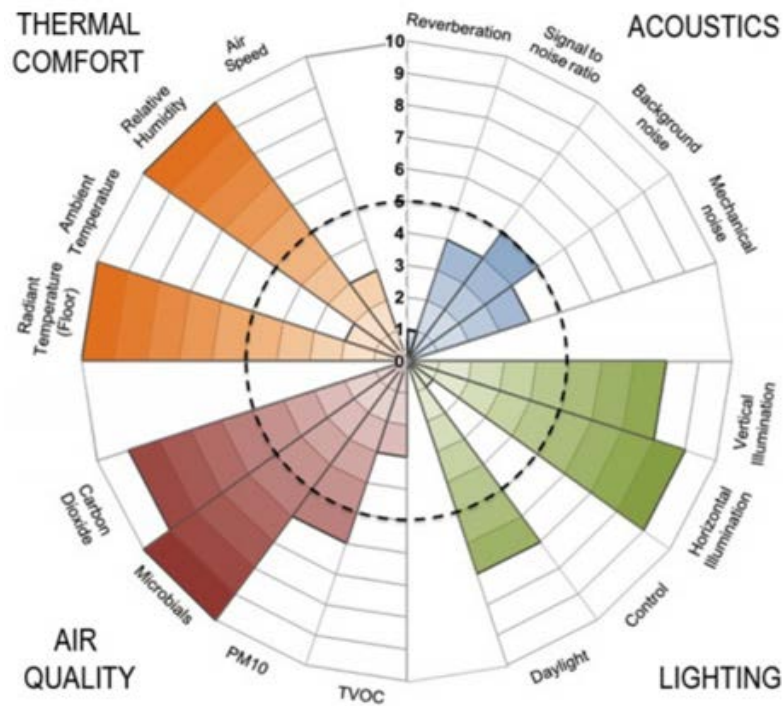
Figure 5-6. Info-graphic EduTool for assessment of environmental factors in educational spaces. (Imms et al., 2016, p.195).

Figure 5-7. Indoor environment quality traits remain in the interface of effective learning conditions (Imms et al., 2016).

Learning Landscapes project was proposed as an alternative method, which reaffirms the idea that maintained departmental or disciplinary boundaries cause misinterpretation of missions and fragmented communication of duties. This motive justifies contemporary campus management to aim for the involvement of all campus members through a conversation. Understanding innovative spatial norms and setting productive measures on space to cost relation. Nonetheless, challenging the arguments on spaces has not been prioritized as needed in the research agenda. An approach suggests more of an artistic method for the evaluation of campus environments in multiple dimensions. This mapping method consists of different criteria sorted in three headings: expression, efficiency, effectiveness. In Figure 6, the black line represents the campus vision while the columns the reality scores of the current situation. The emerging gaps between those two give an idea of the most urgent development areas in each category. All involved universities provided helpful examples of diversified educational spaces. Figure 7. presents the Learning and Teaching Spaces: emanating from those examples, a bunch of indicative models of learning spaces have been evoked (Neary et al., 2010).
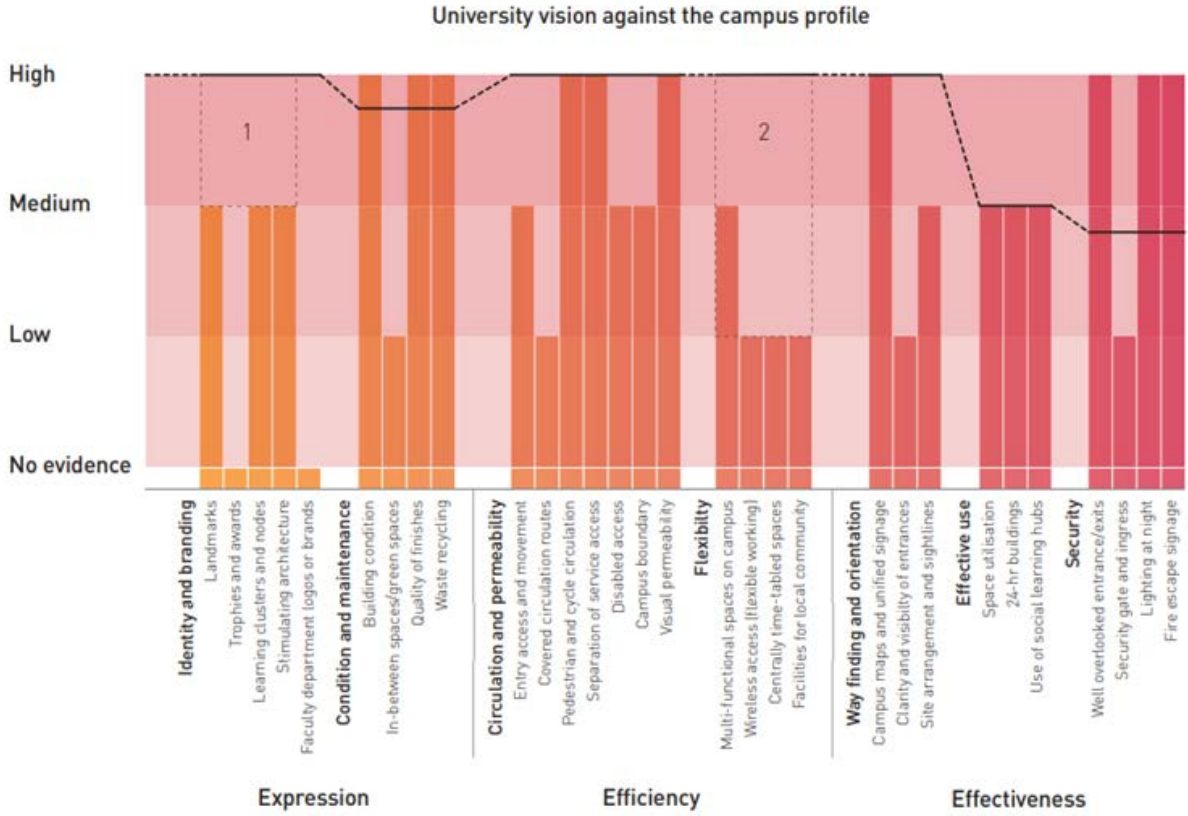
Figure 5-8. Evaluation of campus environments in multiple dimensions today versus the target level to achieve with planned strategies, indicated with the dark line on the top of the graph. (Neary et al., 2010, p. ???)

Social learning spaces provide the campus community an informal setting with adaptable furnishing and digital tools during collaborative events and leisure activities, or just individual study.

Collaborative learning areas, shared tasks and responsibilities assigned to the students for assisting in teaching activities too.

Research and teaching spaces, which would further promote the interconnected nature of research, publishing and teaching in the realm of academy among scholars.

Postgraduate space, exclusively reserved and designed for the scholars at this academic level for specialized study and research.

Experimental teaching spaces offer the scholarly community a wide range of means and materials to enhance their skills in teaching methods and tools.

Teaching spaces particularly integrated with latest technology device and tools, developed with partnership of pedagogy experts and designers.

Figure 5-8. Learning and teaching spaces categorized by mixed functions as required in today's university (Neary et al., 2010).

In the evaluation of collected data, a frequently encountered problem seems to be combining those of different natures. A solution proposal to this conflict is demonstrating the data by means of geographic information system(GIS). GIS technology incorporates various data-sets and translates all in a geographically apprehensive form of visualized information. Through this medium, regulation of spatially-linked data facilitates its interpretation in building information modeling (BIM) originated built environments in HE institutes when a post-occupancy evaluation (POE) is carried out (Göçer, Hua & Göçer, 2015).

6. Performance Evaluation

Evaluation practices have evolved around cultural norms and local circumstances, the same model of standards cannot be implemented commonly or universally. For that reason, rather than contemplating guidelines upon standardization, the investigations should concentrate on how to build and execute them to predispose to the present and future success factors. Evaluation and appraisal models pledge certain standards in high-performance higher education institutes for effective learning. These models have been developed as a vital part of educational activities, as well as a method to uncover the current state of scholarly life quality and fulfillment of its community. Besides, quantitative information such as the organizational prestige or statistics of the institutional productivity have been reflected. However, the cumulative results indicated by performance surveys and inspection reports reveal that a vigorous revision in designing and interpreting the assessment is needed in order to meet the changing demands from all different stakeholders involved in the tertiary education realm. The current formation employed by contemporary higher education venture require an equally matching procedure of evaluation and assessment applications. For instance, deconstructed approach to reduce the complexity of the appraisal methods cannot react suitably to the 21st-century of information in excess. Design of the assessment method is in a converation with places in which students learn, therefore enhancing them has to be an initiative in priority (Higher Education Academy, 2012).

Higher education institutes are expected to satisfy the demands of students in the context of simulating the future employment mediums and gaining professional soft skills. Higher education guiding norms, therefore, shall acknowledge these requirements and guide student preparation by the assessment works. Pedagogical and academic planning in higher education has has spearheaded introduction of the professional life with services such as career development, employment events in collaboration with companies, applied-internships in the relevant expert environment. However, the spaces and environmental conditions in which these activities are carried out have barely changed in contrast with the novel educational approaches. Higher Education Academy (2012) outlines a set of indications to increase the effectivity of evaluation process in universities:

1. Open-minded leadership and fair judgement of the prevailing problems.
2. Student familiarization with the assessment process and the relevant changes, for successful learning as well as the preparation for the future employment.
3. The teaching staff too should be familiarized with evaluative practices and an effective feedback cycle with students.
4. Directions and standards shall be established and respected in their exercise as a tool for improvement.
5. A competent assessment measure would exploit the technological systems and computer softwares to collect and interpret the feedback data, rendering the process transparent and useful for all stakeholders, including the staff and students.

6.1. Performance and satisfaction measures

The practice of evaluation in learning environments is considered still being in its infancy with available methods. Moreover, these measures are anticipated to involve cross-disciplinary assessment indicators, including ergonomy and psychosociology (Imms et al., 2016, pp. 24-25). Arrangement of specified guidelines and descriptions may help evaluations in interdisciplinary learning with its ambiguously defined success indicators (Gouvea, Sawtelle, Geller & Turpen, 2013). Until the recent times, students have never been closely involved with educational evaluation and decision making. Beacuse of the stiff rivalry in higher education industry, students have yet been recognized as active collaborators in university environments, which appeal them with a promised autonomy (Telford & Masson, 2005).

Assessment models that focus on the innovative capability of a learning environment bring out the complex interconnections of people among themselves and with physical amenities. This observation accentuates the misalignment between pedagogy and tangible resources, which results in failure of diversity's co-existence (Imms et al., 2016). In order to overcome the problem of the environmental recalibration on campus, the disregarded interdisciplinary solutions developed by facility management experts could be harnessed by university management. Amaratunga & Baldry (2000) outline several reasons for the restrained employment of FM practices to uphold the assessment activities and performance analysis in the higher education industry:

1. The neglect of inclusive leadership, quantitative research, and engagement of all actors in evaluative actions by FM specialists.

2. The gap between the assessment results and their translation into concrete decisions of intervention.

3. Performance assessment has an experience dimension that requires earlier practice rather than the book knowledge.

4. Management network has been structured inefficiently and inadequately.

6.2. Impact factors in evaluation of spaces

Peter Senge's five principles to achieve an enhanced learning sphere are mentioned as common vision, learning as a team, transformative methods, individual mastery and systems thinking. All aspects are determined based on different group's as well as each participant's needs, through reflection sessions and side activities. The idea of interdisciplinarity nourishes experiential learning and the exploration of new evaluation techniques (Herrington & Herrington, 2006, p.18-19).

Through space improvement projects in campuses, cross-case research identified a five-dimensional model extracted from the case commonalities for campus assessment: *Approach, Motivation, Budget, Outcome Type, Added Value*; each being evaluated on the proper scale that measures the variety of communities with different needs. Thus, an appropriate equilibrium for each unique case was needed considering complex campus systems, which focus on operating activities than the space itself. According to the analysis conducted on selected case studies, campus-level developments exemplify periods of straight, long-standing built environment management tactics, top-to-down decision mechanisms, space-prioritizing motivations, fixed budgets, and standardized outcomes extended over a long time. The result is likely to be justified with demanding management of construction works and assets managed by the interlocking directorate of a campus administration, as well as the long process of defining the right values to bring in (Rytkönen et al., 2015).

According to OECD, there are five criteria determined for an archetypal learning space, in addition for its evaluation: (1) flexibility, (2) community needs, (3) sustainability, (4) safety and security, and (5) economic wealth and funding sources to support the design, use and management of learning spaces. A guide to measure and renovate existing spaces is available regarding those principals, and each project is scored upon both the operational and functional effectiveness (Mei & May, 2018). Moreover, Pillai et al. (2019) report that an exemplary modern learning environment should be able to enable a broad range of needs for each type of knowledge acquisition to enable a more powerful learning practice. Earlier research concludes on four associative elements for a more fulfilling interdisicplinary experience: knowledge work, thinking tools, digital lifestyles and learning research. Besides, a comprehensive collection of guidelines has already enabled a well-rounded system of evaluation, such as UK's Building Research Establishment Environmental Assessment Method (BREEAM) which works in multiple aspects (Durosaiye et al., 2019).

JICS initiated a project called The Defining Spaces for Effective Learning in 2006, which reports the necessity of a solid and reciprocal integration of educational principles with architectural applications. The design of learning spaces should not be thought of a group of resource-consuming built facilities, regarding that these spheres will be used in the next several decades being in constant demand for adaptability for shifting changes. The principle trait recommendations are:

- Progressively active,
- Cooperative with user purposes,
- Inventive,
- Daring towards untested,
- Fluid for ever-changing demands.

A similar guiding publishment has been realized by OECD the same year, under a project called The Programme on Educational Building (PEB) suggesting further criteria:

- Spaces open to the use of all relative associates.
- Involvement of all stakeholder parties.
- Risk-free management in monetary resources and safety compliances.

According to the outcomes of a Ph. D. research conveyed across four Australian tertiary education institutes, the Effective Teaching and Learning Spatial Framework pointed out six aspects that make contemporary learning environments.

1. Engaged students.
2. Student-centred teaching.
3. Education in a social context.
4. Constructivist knowledge gain.
5. Higher-order learning with multiple means of comprehension.
6. Fruitful feedback loop.

Followingly, these results have been translated into spatial characteristics:

- Roominess.
- Mobile and diverse sets of furniture.
- Easy access to digital resources.
- Handy and practical tools in the space.

The author further illustrates the universal key principles of exceptional education institutes:

1. Respecting uniqueness of individuals and learning schedules
2. Promoting collaborative initiative and assisting informal interactions
3. Successful coexistence of multiple purposes in flexible and interactive spaces
4. Prioritizing sustainable methods and tools for procurement of physical facilities
5. Acknowledging that learning happens everywhere as a continuous process beyond campus boundaries, across nature and community at a broader scale (Taylor et al., 2009).

The Innovative Learning Environments (ILE) report of OECD presents forty features of learning environment design to a multidimensional extent (Table 11.) (Imms et al., 2016).

Table 6-1. Some of the architectural terms summarized by OECD report, as characteristics for new generation learning environments (Imms et al., 2016).

Descriptive attributes of modern learning environments

future-proof	relocatable	changing pedagog	flexible	recomposition
bold	creative	supportive	enterprising	purposeful
learner-centred	solution- based	lifelong learning	security and safety	digitized
mobile	virtual spaces	connected	collaborative	inclusive
networked	equality	leisure	cooperation of members	multi-functional
focus areas	multimedia	IT accessible	expert -learner contact	community of the institute
different stakeholders	needs of diverse groups	real-world practice	multiplicity of methods	design quality and guidelines
risk-free finances	availability of resources	content	active learning	educator

In an attempt to create a conceptual process model that would help the campus managers in complex decision making, a study explores eight cases in Aalto University main campus, representing different scales of campus-, school- and pilot-level projects and are situated on one campus of the same university. The cases represent interdisciplinary learning and working environments through spatial transformation. Aalto University is a good example of interdisciplinary university campus facilitation, as it is a merger of three distinct higher education institutions from fields of business, technology and arts. The selection of cases was based on different organizational levels and campus development, which encourage individuals to focus on general adaptation rather than deep discipline specific knowledge and expertise, as well as to informal multi-use spaces. The pilot cases were all developed by transforming empty existing buildings and overlooked spaces to new interdisciplinary cross-organizational uses. The interviews indicated that there is no single recipe that would definitely fit each setting, culture and purpose, but rather multiple different approaches are needed to support the heterogeneous user communities.

6.3. Balanced scorecard (BSC) approach

As performance reviewing in businesses crucially required benchmarking principles for improved efficiency and enterprise functionality, different methods of performance assessment have been developed such as BSC (Balance Score Card) and EFQM (European Foundation for Quality Management), which could be seen promising for the future higher education if reframed and updated based on the unique area specifics of educational operations (Jalaliyoon & Taherdoost, 2012).

Amaratunga and Baldry (2000) refer to the process ''Balanced Scorecard'' (BSC) which arose as a response to the strategies solely concerning monetary aspects of business management and planning, that seizes the complex whole of performance indicators in a business. A proper balance of meaningful information is supposed to provide the university directors with valuable conclusions for creating better educational environments. On the contrary of traditional methods, BSC prescribes a perseverent stance in the application of strategies that would link the near-future objectives to the long term vision for successful outcomes. BSC revises businesses through four principal prospects, to align today's intervention decisions with the overall image and impact an institute intends to create in the long term: financial perspective, customer perspective, the internal business process perspective, and the growth perspective **(Figure 6-1).**

Four perspectives of BSC

Growth and Learning : How to sustain the ability to improve and manage the change

Clients: How to accomplish the vision promised to the customers

Balanced Scorecard Strategy (BSC)

Internal business: How to satisfy all different stakeholders and clients

Finances: How to become successful financially to maintain a well-established status
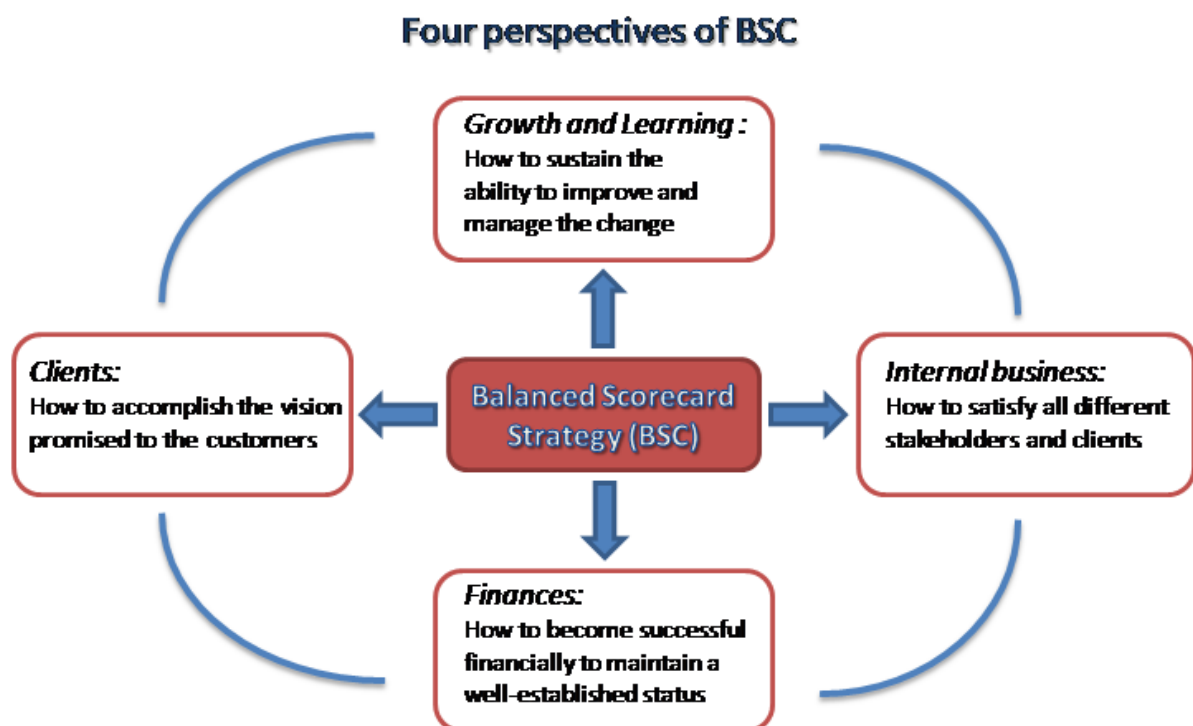
Figure 6-1. The concept of Balanced Scorecard is composed of four different perspectives to achieve an integrated strategy of facility management, to avoid favoring specifically one success measure above the others (Amaratunga & Baldry, 2000).

The performance indicators were chosen in the context of cause and effect relation in BSC. Once these relations are established, their precision is inquired through the superposition of numerous results of the same appraisal model, or statistical data. Also, this approach provides clear distinctions of responsible personnel in the facility management side of the operation throughout assessment activities such as gathering and interpreting the data, decision-making with strategy development, and communication of potential solutions and outcomes with campus agents. These steps initiate a restructured evaluation mechanism within the institute while increasing the efficiency in learning (Amaratunga & Baldry, 2000).

6.4. POE method

Built environment experts assembled in 1990, for further investigation of methods development on how to define and execute a whole and effective facility operation in buildings. The parameters established a process to measure and appraise the performance and it was named "Post Occupancy Evaluation" (POE), which included the user perspective and consequently captured real insights on the functionality based on user expectations. User satisfaction was recognised a direct impact factor on the design and settlement of built campus environments. POE is used in higher education institutes as a correlated tool to facility management (FM) to discern the flaws in implementation, then accordingly restructuring the given spatial circumstances and functions defined within them in compliance with the institutional concept. POE reviews are a valuable method of obtaining feedback on recently completed learning environment projects. Such reviews provide useful information that can be used in two ways. First, to highlight any problems that can be addressed and solved within the project in use and second, to provide lessons that can be used to improve the process and design in future projects. POE is usually carried out about a year after project completion and can include both objective and subjective techniques such as questionnaires, interviews, focus groups, observation, documentation audits and technical monitoring. Ideally, a range of stakeholders as wide as possible should be involved in order to provide a holistic picture of the project, its successes and shortcomings. Thus, an evaluation regarding the user feedback in university buildings would facilitate the preparation of future built asset projects for the decision-makers in favour of increased performance and flexibility in consideration with the user's need.

Ultimately, POE is employed in educational environments for regular inspection of monitorization and control in spaces and activities that determine the learning capability these environments provide. The most prominent benchmarks of over 120 stand out as architectural and engineering qualities, maintenance of gears and equipment the campus workstations own, proper infrastructures and spaces assigned of teaching and learning activities, safety and adequacy codes for the built facilities (Tookaloo & Smith, 2015). The study conducted by Mustafa (2017) in participation with the students of a local university facility in the city of Erbil explores the correspondence of the user POE in an institutional building's performance. The outcomes report the correlation rate as 88%, which affirms the

hypothetical linkage of the user satisfaction measures to the operational performance of edifices as a significant scale. The collaboration of experts from the design and social sciences fields have a potentiality for overcoming the question of how to narrow the gap between conjectural design solutions and human factors. The advantage of the POE approach may end up succeeding in compliance with a diverse category of standards and regulations (Durosaiye et al., 2019).

POE for user satisfaction and correct definition of needs

The construction industry has developed a range of economic and environmental key performance indicators to assess the process performance. The economic KPIs measure client satisfaction, defects, productivity and profitability. The focus of a POE can be considered in terms of three broad areas: Process, Functional Performance and Technical Performance. The functional performance addresses how well the building supports the institution's organisational goals and aspirations and the user needs are met. The encouraged feedback practice through POE will also assist the universities to manage its operational facilities so that change in organisational need and how buildings support that need, can be monitored thereby improving how users are supported.

Table 6-2. The areas covered in a functional performance evaluation, which measures the required effects on occupiers and/or users (Tookaloo & Smith, 2015)

Strategic Value	Achievement of original business objectives
Aesthetics and Image	Harmonious, neutral, iconic, powerful, bland
Space	Size, relationships, adaptability
Comfort	Environmental aspects: lighting, temperature, ventilation, noise, user control
Amenity	Services and equipment: completeness, capacity, positioning
Serviceability	Cleaning, routine maintenance, security, essential changes
Operational Cost	Energy cost, waterand waste, leases, cleaning, insurances
Life-cycle Cost	Initial construction cost, cost of operating, maintenance and repairs, replacement costs, alterations, demolition
Operational Management	Booking and space allocation systems, user support systems, help desks, manuals, training

The POE tool has been discarded from architecture and design domains in the last decades, leaving the charge mostly to environmental psychologists alone. However, according to an advocated set of 12 attributes for an inclusive POE, it is obvious that a multidisciplinary climate for an elaborate assessment is necessary (Hadjri & Crozier, 2009). The ideal trade-off verges for each facility was presented **(Table 6-2)** (Cohen et al., 2001).

Table 6-3. Gathered information from all groups of users in the facilities, based on an assemblage of KPIs narrowed down to Essentials (Cohen et al., 2001)

air quality (in both summer and winter for the last three)	the building overall (its design and how well it meets perceived needs)	personal control (overheating, cooling, lighting etc, together with the speed of response)	speed and effectiveness of management response after complaints have been made
temperature	air movement	lighting	noise
background (age, sex, ethnicity, etc.)	overall comfort	productivity at work	health

Generally it is argued that a POE should be carried out at least a year after occupation. This allows a full seasonal cycle so that information on how the building's systems perform under different seasonal conditions can be captured. Also, it gives users and building managers' time to get used to the building and identify any chronic problems. Ideally, POE is encouraged to conduct at different points of time on the same facility to capture varying opinions and changes in performance in time. Such as;

- 3 to 6 months after occupation(operational review)
- 12 to 18 months (performance review)
- 3 to 5 years (strategic review) (Ahmadi et al., 2016).

A scrutinizing POE is destined to discover the circumstances and collect relative shreds of evidence in varying motivations such as:

- Technical information on building functioning.
- Overall information for design options before planning.
- The interactive dialogue between building and its users.
- Particular investigation on spatial management (Hadjri & Crozier, 2009).

Example case

Hadi and Kiruthiga (2008) set out the findings of the University of Shieffield-Post Occupancy Evaluation (POE) report of the International College Phase 1 project. The Higher Education Design Quality Forum (HEDQF) have developed a POE methodology based on a series of structured facilitated discussions (Forums) to be attended by representatives of all groups involved in the project from 'inception to completion'. A complementary methodology, the DQI (Design Quality Indicator) has been developed by the Construction Industry Council (CIC). This questionnaire-based tool focuses on the assessment of a building in use and is structured in such a way as to encourage discussion of key issues of success or concern. The HEDQF recommended methodology was used as the basis for the evaluation of the process of the project and was supplemented by the DQI for the assessment of the building in use.

The outcomes of the evaluation based on project development and maintenance activities revealed the necessary steps to take in the future projects such as:

- Investigate improvement of HVAC strategy and controls to minimise the cost spent via maintenance.
- Consider the solutions to deal with the solar gain and ventilation issues in the class rooms
- Time should be given to pre-planning and design stages. Estates were not given enough time in the programme to do this properly.
- Leadership by Project Managers is important. The project managers shall be given appropriate responsibility for decisions and for the projects to proceed smoothly.

Table 6-4. The raw data collected at the end of the DQI questionnaire. Respondents were asked to indicate three things that they particularly dislike about the building (Hadi & Kiruthiga, 2008)

Dislikes
The extremely erratic heating!
Windows are not double glazed, so it gets cold after sunset
Toilets are all concentrated in one part of the building - would be better spread out.
Internal temperature
Cramped rooms
Inadequate natural daylight
the heating is completely unpredictable
I seem to spend hours roaming corridors - poor layout
narrow corridors become crowded with students
The upper half of the building is in terrible disrepair
Not enough space for the amount of students and staff using the college
Pigeons fly into building through broken windows in upper two floors

The second session focused on the project in use and was attended by occupants, both staff and students. The sessions were based around the completion of the Design Quality Indicator (DQI). The DQI is a questionnaire based tool that helps clients, designers and end users to evaluate how well a completed building has been designed and constructed. The questionnaire consists of a series of short non-technical statements looking at the given criteria:

- Functionality looks at the way the building is designed to be useful.
- Build Quality looks at the materials and the different systems and conditions inside the building.
- Impact refers to a building's effects on the local community and environment.

In future refurbishments, the possibility of the following aspects should be given more consideration:

- Flexible layouts, acoustics and ventilation as an integral part of class room design.
- Integrating additional hot desk facilities, lockers and staff room requirements.
- Quiet reading room or library facilities.
- Informal student breakout spaces, for casual meetings for staff and students.
- Student locker and drinking water facility (Hadi & Kiruthiga, 2008).

7. Findings
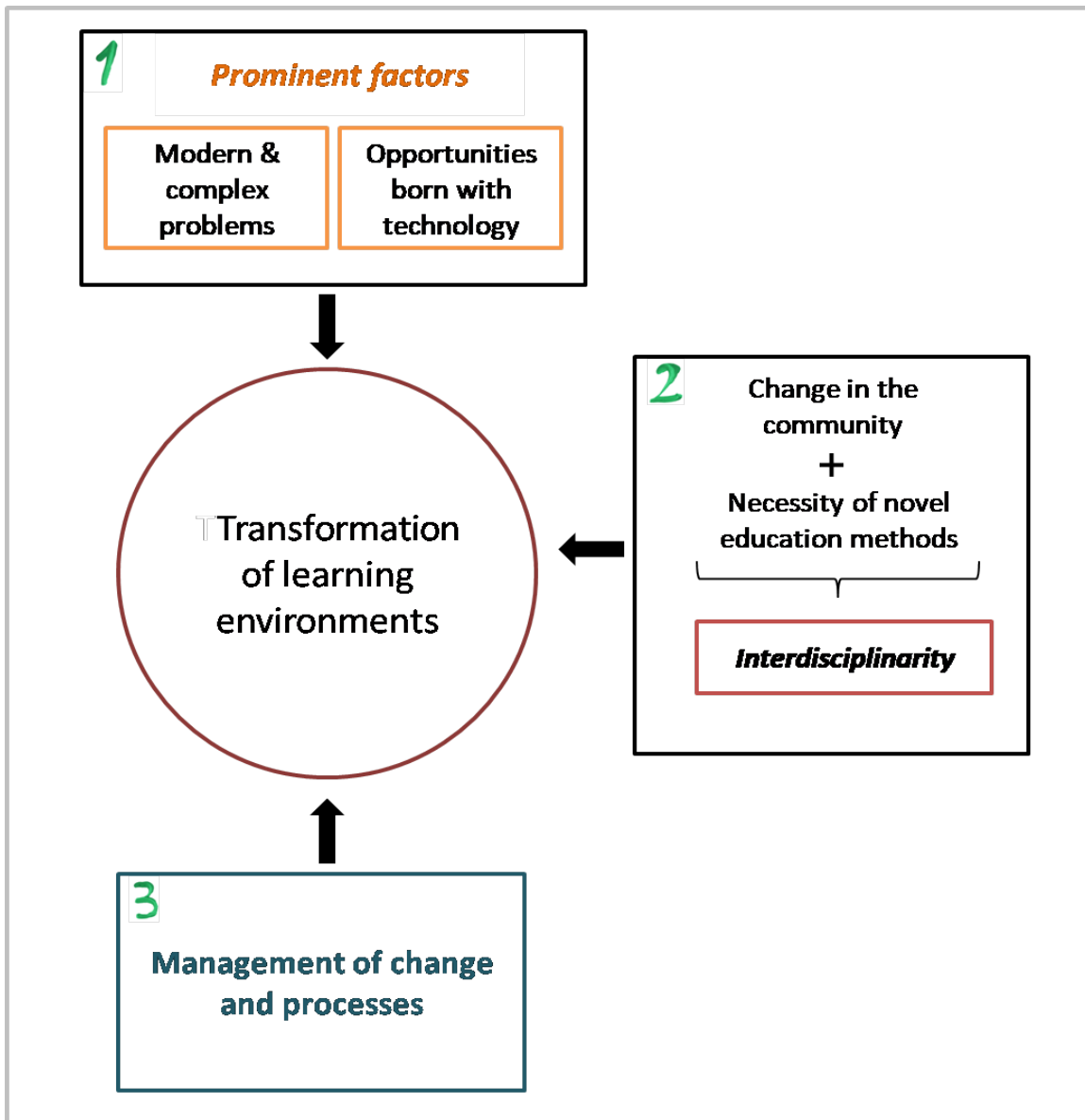
- Contemporary issues call for complex thinking, unavoidable employment of digital support structures, and management of interdependent systems at organizations.
- Interdisciplinarity appears as a side-development of economic, societal, and technological changes, rather than an element that is intentionally employed in complex higher education environments.
- However, an interdisciplinary approach in the transformation of educational spaces favours to several diverse aspects in development planning –the student profile, pedagogical changes, management technologies and techniques, design thinking in the learning process and raising well-equipped solutionist in response to global challenges.

Interdisciplinarity | Environmental transformation

Societal change
Future needs in education
Authority pressure

Socialized
Experiential
Constructive
Transformative
Digital / virtual

Adaptable
Informal
Blurred-boundaries
Open & accessible

Benefits

Life-long development
Employability
Research
Innovation

Learning process
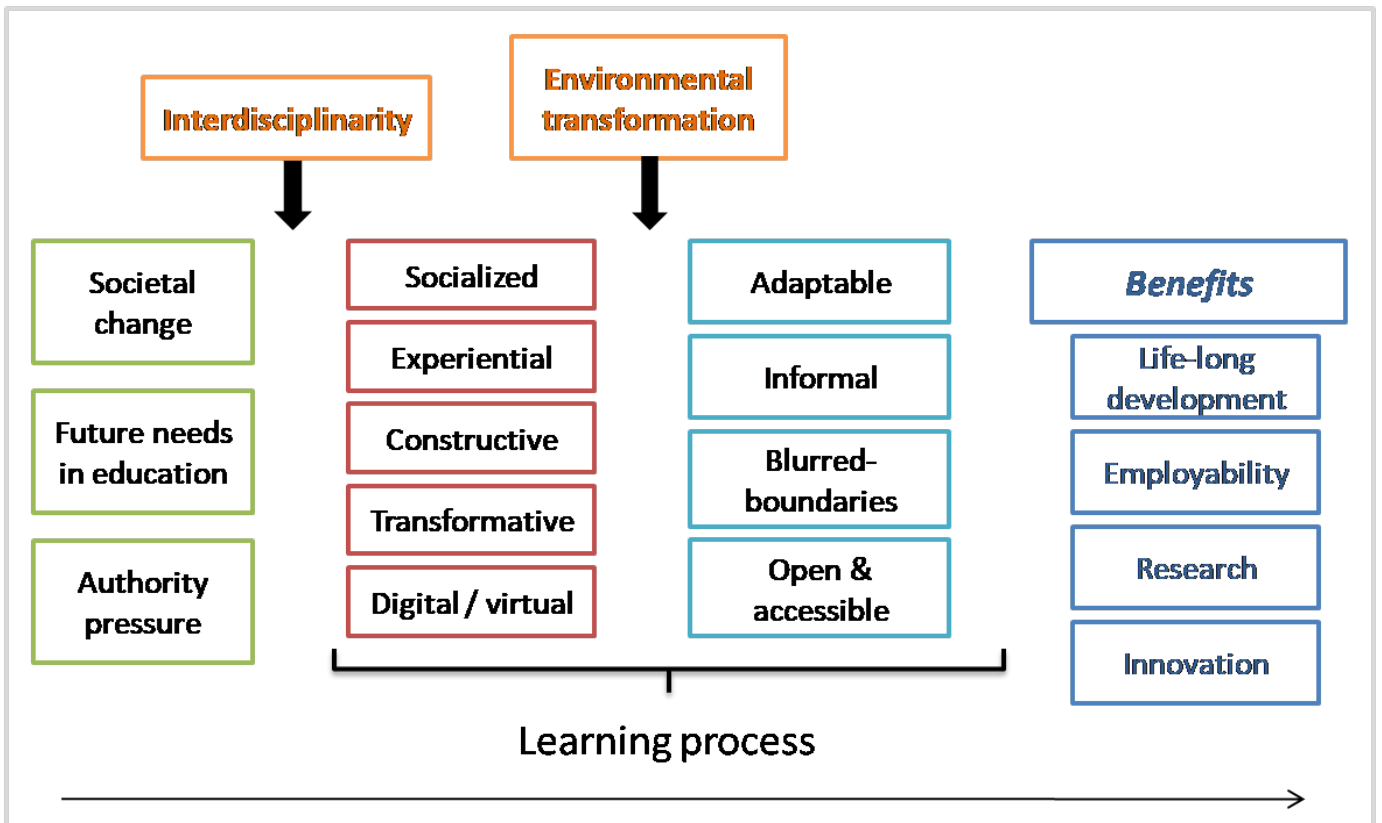
1. External impact factors translate into inevitably altering methods of education through interdisciplinary thinking.
2. These changes in rethinking tertiary education require the modernization and enhancement of learning environments along with it.
3. Driven by the interdisicplinary and future-proof principles of higher education institutes, campus environments gradually make room for flexibility, adaptability and interpretation while eliminating traditional space codes such as rigid library or lecture hall layouts.
4. Eventually, the long-term benefits of this stagewise and mutual evolution in society and educational interdisciplinarity nurture each other which lead to a state of constant research, innovation and learning at any age and stage.

SECTION 2 : Multiple Case Study

The Case Study

Following the literature review, which introduced environmental and spatial evolution of higher education in effectively launching interdisciplinarity, nine unique university projects were selected. The main objective of the case study is to emanate a comprehensive insight to the elements that generate interdisciplinary thinking across campus environments, and providing a comparison of this occurrence through real projects in mutual argumentation with the findings from the literature review section. In relation to that, this work inquired both the correspondence and differences between theoretical affirmation and present applications on interdisciplinary higher education environments.

These institutes ultimately illustrate innovative regulations and incorporation of interdisciplinary methods by modern definition. In accordance with that set of terminology, the pedagogical methods and science of teaching were repetitively stressed subjects. As a more technical approach, quality assurance of built assets proposed principles to properly evaluate the physical capacity of a built environment of educational activities. Beyond those, re-evaluation of campus culture and active student engagement in order to create a cross-boundary medium of typically specialized departments was frequently mentioned, which would enrich the campus experience and success of the educational outcomes.

The official university websites and online architectural resources were reviewed in order to find and pick appropriate environmental recreation projects in higher education institutes. The main strategy applied is empirical observation, which is based on the design principles and project vision from a qualitative perspective. The cases attempt to showcase how modern and interdisciplinary facilities are structured, presenting the core ideas underlying each specific context through table subdivisions. The cases were further examined through a discovery of the most frequently encountered keywords in the reports of institutional strategy and vision. However, the selected cases do not necessarily diversify in location, campus type (urban or upstate, scattered or concentrated) neither in degree of innovation. These projects vary on the quality of spaces, financial partnerships, and very importantly in their degree of spatial feasibility and intimacy. Despite the complexity and subjectivity the cases display, they are broken down in different features in to ensure a simplified examination. Each higher education facility in the following reveals a different manifestation of either civic values or institutional vision, although; the evident and common endeavour of all is modernization in response to blending boundaries in curricular disciplines, thus, learning environments.

First of all, the case introduction table **(Table 2-1)** showcases the selected projects and the belonging higher education organizations. The primary functions of each project and project locations were displayed in order to elaborate a preliminary framework of the study content. The subsequent list of definitions display the classification of the information and its potential significance for the study.

Table 2-1: The list of the higher education campus projects examined in this study, given with respective geographical and functional distinction.

Case no.	Project name and organization	Function	Location
1	The Hub, Coventry University	Multi-purpose innovation center, leisure services	Coventry, UK
2	Erasmus Pavilion, Erasmus University	Multi-purpose and sustainable center, leisure services	Rotterdam, NETHERLANDS
3	The Boilerhouse, University of Western Sydney	Leisure services, informal interaction	Sydney, AUSTRALIA
4	Harald Herlin Learning Center, Aalto University	Multipurpose and collaborative learning, informal leisure	Helsinki, FINLAND
5	University Square, University of East London + Birkbeck University	Interdisicplinary learning and research	London, UK
6	Perry and Marty Granoff Center, Brown University	Multidisciplinary creative arts	Rhode Island, US
7	Campus expansion, California College of the Arts	Collaborative research and innovation, sustainable context	San Francisco, US
8	Campus-wide renovations, University of Cambridge	Accessible and collaborative teaching, informal leisure	Cambridge, UK
9	The new Engineering Heartspace, University of Sheffield	Social and research collaboration space	South Yorkshire, UK

The investigation that unfolds in the following employs an approach of inter-institutional comparison through the first part of the tables. The context concentrates on the departmental division, which reflects the foundational idea behind the campus structure, then immediately followed by the second part of a transformation project realized on campus that centred around the contemporary user needs; whereupon, interdisciplinary principles.

The correspondonce level of the findings from Section 1 (literature review) and Section 2 (case presentation) would be highly depending on clearly defined quality indicators. However, the case comparison in this study mostly relies on very general indicators with the objective of uncovering the most influential and commonly employed elements in development of interdisciplinary campus environments. At the end, the findings were summarized as the result of a qualitative comparison of the real life environmental re-creation projects on university campuses to the literature statements.

1. List of Definitions

Location	City and country of campus location, for geographical distinction of the cases while defining similarities, differences and limitations.
Type	Public or private, for which may determine the extent to budgetary limits and funding specialized hardware infrastructure, as well as academic administrative structure.
Completion year	Indicates the date on which the chosen facility returned / launched to community use due to its renovation/completion.
Budget	The total estimated cost for the project.
Area	Effective floor area of the project.
Number of students	Total official number of students in the institute.
Disciplinary Departments	Each disciplinary division/unit of the institute.
Project Vision	The unique goals to achieve through an approach inspired by the 21st century campus needs.
Functional divisions	Understanding the spatial distinction or zoning educational and non-educational activities within a space and the manner of realizing it.
Project key principles:	Descriptive terminology highlighting the core ambitions and primary objectives of the project execution.
Design highlights	The most unconventional or unusual design-related element or spatial characteristic of the project environment.
Specific recognitions	Awards or worth-mentioning aspects of a project.

2. Institution overview and project inquiries

1. COVENTRY UNIVERSITY (UK)

Location:	Coventry, United Kingdom
Type:	Public university
Completion year:	2011
Architects:	Hawkins/Brown
Budget:	19 million pound
Area:	8950 sqm
Number of students:	31,700 (by 2017)

Disciplinary Departments:
- Coventry is divided into four faculties, each divided into different schools:
  1. Faculty of Arts and Humanities
  2. Faculty of Business and Law
  3. Faculty of Engineering, Environment and Computing
  4. Faculty of Health and Life Sciences

Project: THE HUB   2011

Project Vision:
- A <u>centre</u> for campus life.
- New <u>social learning</u> facilities.
- A <u>multi-purpose</u> venue
- <u>Cross-disciplinary</u> interaction
- Transforming the <u>student experience</u>.

Functional divisions:
- Essential shopping, food courts, cafeteria
- The Tank Studio: multimedia production and broadcasting studios
- Square One: social and informal learning, an entertainment venue
- Students' Union and Advice Centre

Project key principles:
- Wellbeing
- Inclusiveness
- Innovation
- Modernization
- Sustainability
- Sociability
- Individual development

Design highlights:
- The Hub's striking façade draws inspiration from the decorative glasses of local Coventry Cathedral.
- directional signs and common language was selected 'Signal Yellow' for it's vibrancy

and ultimate visibility.

Sustainability and recognitions:
- BREEAM 'excellent' rating
- Education Estates Awards 2014 - Innovation in Teaching and Learning

Image 1. Sociability and multi-functionality were given life in the student hub with informal leisure installments. (The Hub, 2020)

Image 2. A common language of design was determined and maintained across the space. (The Hub, 2020)

Image 3. The cafeteria offers the hub users an informal context to mingle or take a quick break from individual studies. (The Hub, 2020)

Image 4. (The Hub, 2020).

2. ERASMUS UNIVERSITY (NETHERLANDS)

Location:	Rotterdam, Netherlands
Type:	Public University
Completion year:	2013
Architects:	Powerhouse Company & De Zwarte Hond
Budget:	5.2 million euros
Area:	1800 sqm
Number of students:	31,000 (by 2018)

Disciplinary Departments:

- Erasmus University of Rotterdam operates divided into different schools:

1. School of Economics

2. School of Management, Erasmus University

3. School of Law

4. School of Social and Behavioural Sciences

5. School of History, Culture and Communication

6. School of Philosophy

7. Erasmus Medical Center

8. School of Health Policy & Management

9. * Massive Open Online Courses (MOOCs) are soon to be launched in addition.

Project: ERASMUS PAVILION   2013

Project Vision:
- A new social corridor in the <u>heart</u> of the campus
- An inspiring and <u>mixed program</u> of science, art, culture, and society
- A transparent and low-consumption <u>landmark</u>
- Re-arrangeable setting and <u>adaptability of spaces</u>

Functional divisions:
- Cafè, and informal gathering spaces
- An auditorium for both private and public events.
- Atop this central core, there is a multipurpose auditorium that offers room for lectures, performances, and debates.

Project key principles:
- Sustainability
- Usability
- Accessibility
- Multifunctionality
- Adaptability

Design highlights:
- Welcoming spaces and a casual cafe atmosphere
- The "logistical core" efficiently distributes the spaces around itself.
- Smart mixture of functions.
- High flexibility in use.
- Adjustable facade and natural ventilation.

Sustainability and recognitions:
- Energy Performance Certificate grade, 0.2, or A++ (the highest)

Image 5. The cafè provides a casual first encounter with the space, keeping the visual contact with outdoors continuous.(Van der Kooy & De Wit, 2014)

Image 6. In the heart of the campus, the Pavilion welcomes anyone happening to stop by the university with prioritized accessibility on two different levels that are joined by the design. (Van der Kooy & De Wit, 2014)

Image 7. Transparent walls ensure a smooth composition of the landscape and the Pavilion together. (Van der Kooy & De Wit, 2014)
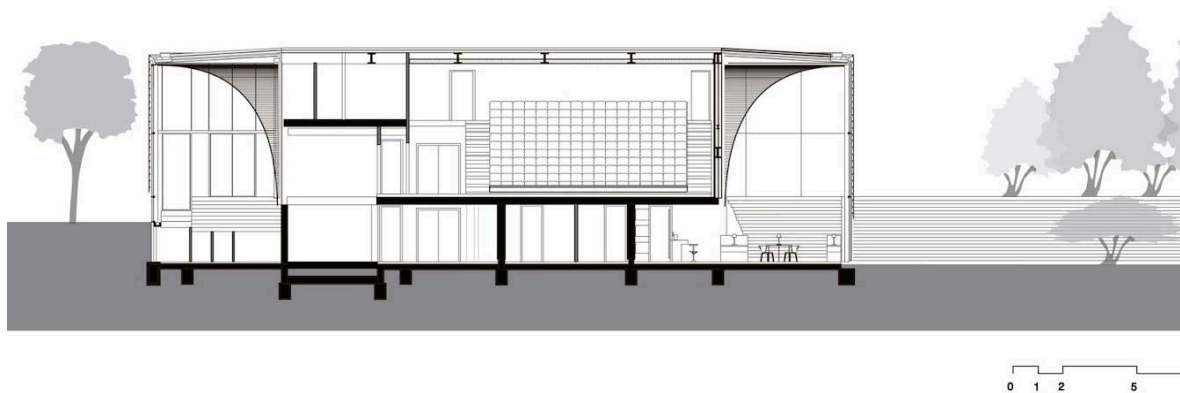
Image 8. The obscured core of the project, which hosts events and demonstrative meetings, leaves the space underneath and on sides to liberate the user choices on what activities to carry out. (Van der Kooy & De Wit, 2014)

3. UNIVERSITY OF WESTERN SYDNEY (AU)	
Location:	Sydney, AUSTRALIA
Type:	Public University
Completion year (renovation):	2013
Architects:	Tanner Kibble Denton Architects
Budget:	5 million dollars
Area:	1800 sqm
Number of students:	45,000 (by 2017)

Disciplinary Departments:
- Being an Australian multi-campus university in the Greater Western region of Sydney, Australia, as of January 2020 the divisions are in the following:
  1. School of Business
  2. School of Education
  3. School of Humanities and Communication Arts
  4. School of Law
  5. School of Medicine
  6. School of Engineering
  7. School of Nursing and Midwifery
  8. School of Health
  9. School of Science
  10. School of Social Sciences
  11. School of Psychology
  12. School of Computing, Mathematics, Statistics and Data Science
  13. School of the Built Environment, Architecture and Industrial Design

Project: THE BOILERHOUSE   2013

Project Vision:
- A new social zone in the <u>heart of the campus</u>
- <u>Mixed activities</u> and daily encounters happening under the same roof
- Re-arrangeable and <u>flexible</u> setting

Functional divisions:
-   None. A continuous and open space.

Project key principles:
- Sustainability
- Usability
- Accessibility
- Landmark renovation

Design highlights:
-   Welcoming spaces and a cafe atmosphere as a go-to hub/home

Sustainability and recognitions:
Energy Performance Certificate grade, 0.2, or A++ (the highest)

Image 9. An accessible social corridor to share leisure time and casually interact.(Koury, 2012)

Image 10. Re-arrangable semi-outdoor space. (Koury, 2012)

4. AALTO UNIVERSITY (FINLAND)

Location:	Helsinki, FINLAND
Type:	Public
Completion year (renovation):	2017
Architects:	Architects NRT & JKMM Architects
Budget:	Not stated
Area:	7505 sqm
Number of students:	17,563 (by 2016)

Disciplinary Departments:
- School of Engineering
- School of Business
- School of Chemical Engineering
- School of Science
- School of Electrical Engineering
- School of Arts, Design and Architecture

Project: HARALD HERLIN LEARNING CENTER   2017

Project Vision:
- Creative and research-oriented facility.
- Cross-disciplinary interaction.
- Supporting both solitary and collaborative working.
- Creating a cultural centre.
- A unique venue of design and business.

Functional divisions:
- Cafeteria
- Media spaces
- Social interaction and relaxation zones
- Research-dedicated rooms

Project key principles:
- Interdisciplinarity
- Minimalism and multi-functionality
- Imagination
- Accessibility
- Innovation
- Equality
- Collaboration
- Sustainable development

Design highlights:
- A village-like area
- Abundant interiors lighting
- Both individual and group-working
- Novel media production spaces.

Specific recognitions:
- No

Image 11. Spacious and well-illuminated research zone for individua studies. (Uusheimo, 2017)

Image 12. Multi-media production studios and printed resources consultancy. (Uusheimo, 2017)

Image 13. Coffee bar on upper atrium with tables and electric outlet, casually furnished shared space and activity rooms on the lower floor for informal or last-minute events and meetings. (Uusheimo, 2017)

Image 14. Engaging design of Harald Herlin Learning Center of Aalto University. (Uusheimo, 2017)

5. UNIVERSITY OF EAST LONDON + BIRKBECK UNIVERSITY OF LONDON (UK)

The project is a unique partnership between Birkbeck University of London (1823) and the University of East London (1892).

Location:	Stratford, London (UK)
Type:	

- University of East London: public
- Birkbeck University of London: public

Completion year (renovation):	2013
Architects:	David Perkin
Budget:	33 million pounds
Area:	8,600 sqm
Number of students (project target capacity):	3,400

- University of East London: 13,215
- Birkbeck University of London: 12,915

Disciplinary Departments:

- The joint facility offers a wide range of bachelor degree programs that are structured as part-time or evening school. Alternatively, certificate courses and foundation degree courses are being held. The schools are divided between partner universities:

Organized by UEL

1. Institute of Performing Arts Courses
2. Law Courses
3. MBAs

Organized by Birkbeck

1. Accounting and business
2. Social sciences
3. Language and global politics
4. Physics and mathematics
5. Information technology
6. Counselling skills and public development

Project: UNIVERSITY SQUARE   2013

Project Vision:

- A major educational hub to meet the growing aspirations of local people at a time of great change and opportunity in east London.
- Offering multi-program courses and a university qualification.
- A partnership center that provides state-of-the-art facilities and student support services including education advice and guidance team.

Functional divisions:

- Flexible lecture theatres
- Performance spaces
- Student advice centre
- IT helpdesk
- A learning resource centre

- Cafeteria

Project key principles:
- Creativity
- Innovation
- Easy accessibility
- Digitization and new media
- Clever reuse of an existing site
- The use of facility management best practices

Design highlights:
- Concrete and timber are combined to give the interiors a robust but warm atmosphere to ensure an inviting environment.
- There is a public garden on the eastern side of the building. There are 80 cycle storage racks in the garden and showers for the use of cyclists in the building.

Specific recognitions:
- 'Excellent' BREEAM certification.
- Recognised for innovation by the Higher Education Funding Council (HEFCE).
- New London Awards 2014 (Shortlisted) - Education

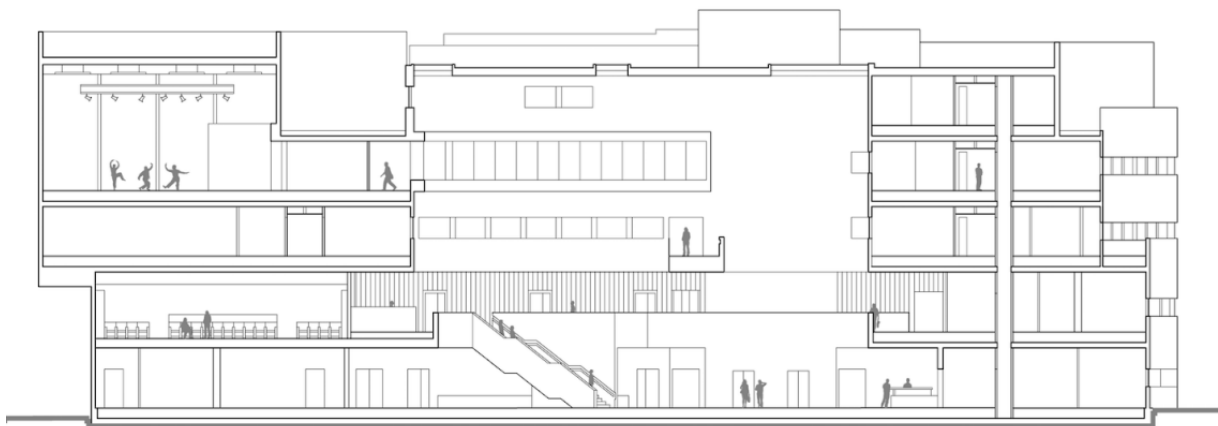*Image 15. Spaces formed around a shared and wide atrium inviting users to interact and encourage collaboration. (''Make'', 2020)*

Image 16. Dynamically designed functional elevations and blurred boundaries of specific zones. (''Make'', 2020)

6. BROWN UNIVERSITY (US)

The department was developed as an organization that works within Brown University, among all other over 300 unions. The multipurpose facility is the home to Brown Arts Initiative.

Location:	Providence, Rhode Island, (US)
Type:	Private
Completion year (renovation):	2011
Architects:	Diller Scofidio + Renfro
Budget:	40 million dollars
Area:	335 sqm
Number of students:	10,257

Disciplinary Departments:
- The university comprises;
    1. the College
    2. the Graduate School
    3. Alpert Medical School
    4. the School of Engineering
    5. the School of Public Health
    6. the School of Professional Studies (including the Executive MBA program)
    7. International degree programs

Project :   PERRY AND MARTY GRANOFF CENTER FOR THE CREATIVE ARTS   2011

Project Vision:
- Collaboration, and extend the knowledge of the creative process
- Stimulating a collaborative environment with flexibility
- Merging the architectural gesture and academic pedagogy
- To advance innovative attitude in activities of research, teaching, and production across individual arts disciplines.
- Multi-use lobby/event space.
- An overall feeling of lightness and airiness in spaces

Functional divisions:
- Performance space
- Exhibition areas
- Installations
- An outdoor amphitheater

Project key principles:
- Creativity
- Collaboration
- Innovation at the overlap of arts and academy
- Setting An Example
- Transparency
- Accessibility

Design highlights:
- Transparent approach of its architecture would welcome the public and expose the art in process.
- Long structural spans, high ceilings, and large floor plates generates uninterrupted interior spaces
- A split level structure, creating an intentional misalignment, is displaced in section to create six half-levels that derive from a stacked floor slab system.

green spaces provide a central pedestrian connector linking the facility to the rest of campus.

Specific recognitions:
- LEED Gold certification

Image 17. Creativity and transparency are manifested on the exterior of the multidisciplinary art center.

(Baan, 2011)
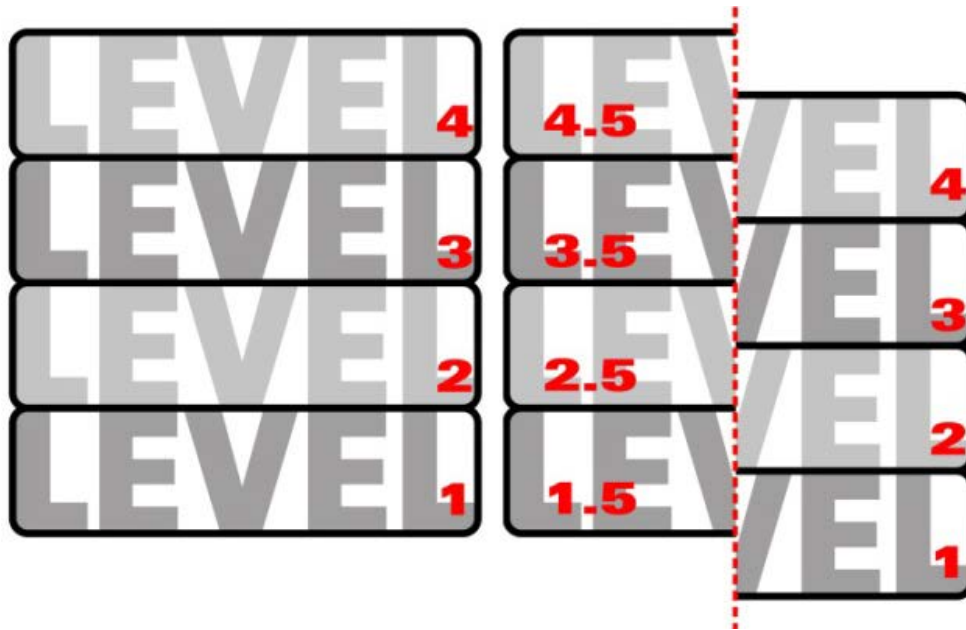
Image 18. Collaboration and accessibility for all were taken as main design principles since the beginning. (Baan, 2011)

Image 19. The innovative building plan displays the multi-functionality of the spaces within. (Baan, 2011)
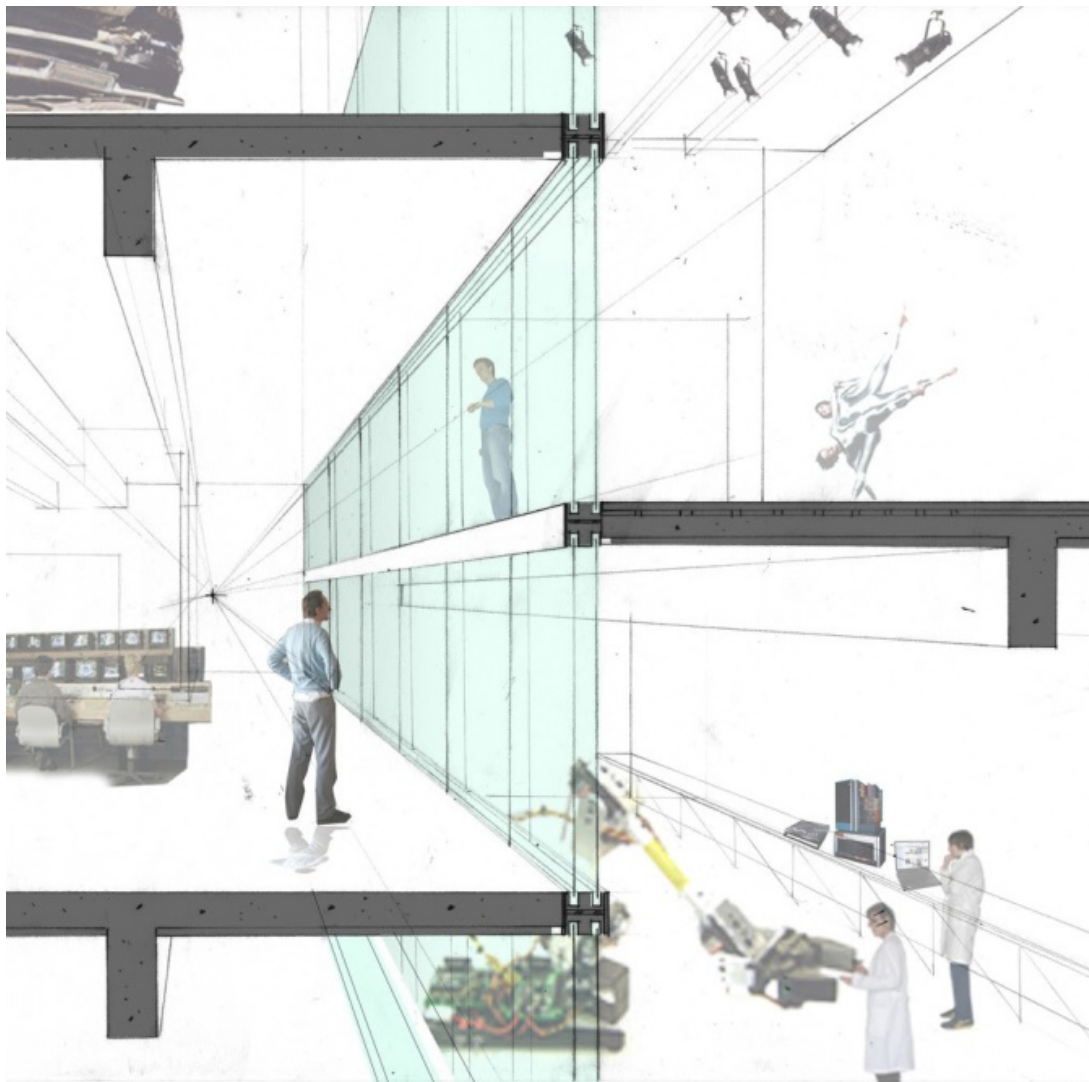
Image 20. Technical details on a cross-section merged with a perspective sketch reflecting the project's aspiration. (Baan, 2011)

7. CALIFORNIA COLLEGE OF THE ARTS, Campus San Francisco (US)

Following the destruction of his home and workshop in the San Francisco earthquake, German-born cabinetmaker and art teacher, Frederick Meyer establishes the School of the California Guild of Arts. In 1999, the college celebrates the completion of the San Francisco campus with an opening gala.

Location:	San Francisco, California (US)
Type:	Private
Foundation year:	1907
Renovation:	1999, actively keeps expanding since 2011

Architects:	Studio Gang
Budget:	27.5 million dollars
Area:	9500 sqm + 15,000 sqm expansion
Number of students:	2000

Disciplinary Departments:

- Except for the Graduate and Undersgraduate degree programs, minors are offered as interdisciplinary courseworks, including Critical Studies, Diversity Studies. Mainly divided in four core disciplines:
    1. Architecture
    2. Fine Arts
    3. Design
    4. Humanities + Sciences

Project :   CCA Campus San Francisco Renovation   2019-*ongoing*

Project Vision:

- <u>Unifying disciplines</u>: mainly art, design, architecture, and writing
- Cultural, social, and environmental <u>impact</u>.
- Interdisciplinarity to support a <u>flexible, future-proof</u> and sustainable learning.

Functional divisions

- Analog and digital making studios
- Generous outdoor spaces
- Exhibition areas
- Specialized labs for experimentation and media production
-

Project key principles:

- Flexibility
- Interdisciplinarity
- Collaboration

Design highlights:

- A welcoming, flexible, and eco-friendly campus
- Inspired by material and community
- Many of the new campus's shops and studios open into shared maker yards, ideal for teamwork and exploring projects that incorporate different disciplines.
- Network of park-like gardens and plazas, wheich students can exploit for spontaneous social gatherings, industry meetups, or simply taking in the sun.

Specific recognitions:

- no

Image 21. Interactive areas for off-lecture time was carefully considered for student's best campus experience.(''Newsweek'', n.d)
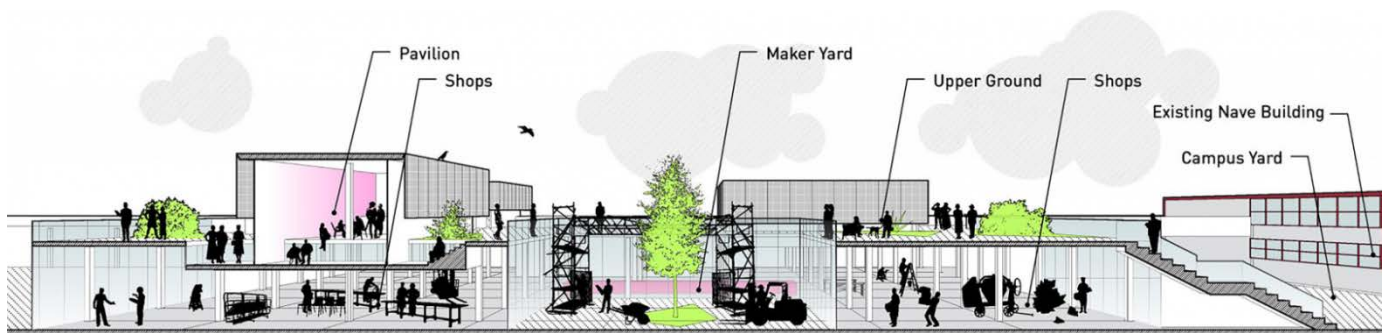
Image 22. Juxtaposition of functions and activities were intentionally planned through layeredspace complexes. (California College of the Arts, n.d)

Image 23. Render from the campus expension project. (California College of the Arts, n.d)

8. The Shared Facilities Hub, UNIVERSITY OF CAMBRIDGE, Cambridge (UK)

The University is undertaking the greatest expansion in its history to be able to create a new science and technology campus to the west of the city centre.

Location:	Cambridge (UK)
Type:	Public
Foundation year:	1209
Area:	Campus expanding over 288 hectares.
Number of students:	22.500 (2018)

Disciplinary Departments:

- There are six schools in total. The university also has a centre for part-time study, the *Institute of Continuing Education*.
  1. Arts and Humanities
  2. Biological Sciences
  3. Clinical Medicine
  4. Humanities and Social Sciences
  5. Physical Sciences
  6. Technology

Project :   THE SHARED FACILITIES HUB   *ongoing*

Project Vision:

- <u>Blending pedagogy</u> with experiment

- Strong support for researchers

- Extended dissemination, and application of knowledge.

- Impact on the <u>local community</u> and broader academic domain.

- <u>Innovative partnerships</u> with business, charitable foundations, and healthcare.

Functional divisions:

- Libraries
- Computing and IT
- Language centre
- Museums and collections
- Interdisciplinary research centres

Project key principles:

- Accessibility
- Integration
- Collaboration
- Lifelong learning
- Interdisciplinarity
- Sustainability

Design highlights:

- Dynamic
- Highly flexible new
- Inclusive to wider public
- A research campus.

Specific recognitions:

- no

Image 24. Render from the design stages of The Shared Hub, stresses the accessibility to wider community and multi-disciplinarity. (University of Cambridge Shared Facilities Hub, 2020)

9. UNIVERSITY OF SHEFFIELD, Cambridge (UK)

A multi-campus university predominantly over two campus areas: the Western Bank and the St George's.

Location:	South Yorkshire, England (UK)
Type:	Public
Foundation year:	1897
Renovation: The most recent addition to the university is the new Engineering Heartspace, opened in January 2020 and has been shortlisted for two prestigious awards in the categories of both 'education' and 'heritage'. The state-of-the-art project houses teaching and social spaces under a new, impressive curved glass roof which links the two long-standing historic buildings of the campus. Alongside the new laboratories, office space and café, the Engineering Heartspace has its own Employability Hub committed to help students and businesses collaborate, as well as bringing 'real world experience' to the student experience in the University's Engineering Faculty.	
Area:	Not stated
Number of students:	30,195 (2018/19)

Disciplinary Departments: There are five faculties and three schools in total, in addition, the International Faculty – Sheffield International City College (SIC), located in Thessaloniki, Greece.

1. Faculty of Arts and Humanities
2. Faculty of Science
3. Faculty of Social Sciences
4. Faculty of Engineering
5. Faculty of Medicine, Dentistry and Health

6. School of Architecture
7. Management School
8. Medical School

Project: The New Engineering HEARTSPACE (Western Bank campus)   2020

Project Vision:

- Interdisciplinary courses
- Clearly-defined thematic focus of study
- Emphasis of complex issues and cross-disciplinary fields of study
- Joint activities with external partners for mutual benefit

Functional divisions:

- Teaching and social spaces
- State-of-the-art laboratories
- Office space
- Café

Project key principles:

- Modernisation
- Performance enhancement
- Transformation through refurbishment and extension
- Impact
- Discovery
- Collaboration between students and businesses

Design highlights:

- A 'repair rather than replace' approach
- Refurbishment and roof addition.
- Enhanced building performance in priority.
- Harnessing the underused courtyard for new functions

Sustainability and recognitions:

- no

Image 25. Sheffield's Engineering Heartspace illustrates an inviting inter-space for varying functions. (The University of Shieffield, 2020)

Image 26. The project exemplifies a successful initiative of re-discovery and refurbishment of overlooked possibilities on campus. (The University of Shieffield, 2020)

In summary, each project was supported by a set of prominent visionary principles that underpin the intended results the respective higher education institutions would achieve. The descriptive presentations of selected projects and ambitions stated by university strategical reports converge on several fundamental points when both resources are carefully read through and a specific framework of terminology is noted down. For that reason, the elements distinctly pronounced in all different contexts were concluded in a synthesis table below. As visionary principles were stated in the organizational reports of future-proof strategy, which are given in the first column, have been translated into accomplished university facilities with different names as revealed in the second column. To say, interdisciplinarity can be achieved on multiple stages of definition and execution. For instance, inclusiveness as a visionary element transcribes into more adaptable spaces with flexible setting and modifiable divisions, which can be pedagogically interpreted as a more collaboration-boosting educational environment on campus.

3. Findings

Table 2-2: Results drawn from the joit evaluation on the first two sections.

◎ Different levels on which interdisciplinarity achieves success when simultaneusly implemented.

◎ Interdisciplinarity as a phenomenon itself, followed by its fundamental components, proposed by this work.

Vision context: ⟷	Physical facility context: ⟷	Educational activity context:
Interdisciplinarity	Multi-functionality	Cross-disciplinary pedagogy
Sociability	A landmark, campus center	Informal learning
Innovation	Modernization	A complete experience of student development
Sustainability	Performance enhancement through digital and tech-tools	Wellbeing
Inclusiveness	Adaptability, flexibility	Collaboration

Results:

- Since interdisciplinarity is a recent act, many institutes with a foundation of disciplinary departments apply a cross-boundary approach through blending specialization studies to stimulate interdisciplinary activities.

- There is no standardized guidelines to create interdisciplinary and collaborative environments, but definition of core common characteristics would be feasible.

- In order to lead the changing process, an institution should state clear strategies and coherent plans to achieve these.
- Research, self-engagement and innovation play the key role in establishing an interdisciplinary campus community, as suggested by the modern pedagogy.
- Multi-functionality, vaguely noted spatial boundaries and increasing informality in campus environments together the principles commonly harnessed by campuses to create stimulating and accommodating tertiary education environments. Therefore, co-existence of diversity in spaces and functions in real cases confirm the physical proximity playing a crucial role in cross-boundary activities.
- Design-thinking has been more widely adopted by universities; since the overall student experience becomes a primary concern in spatial and educational planning.
- Inclusiveness, in-person social connection and technology-integrated sources are inseparable from remarkable interdisciplinary environments.

SECTION 3: Discussion upon comparison tables & Conclusion

Discussion

The indications suggested by the literature review and findings from the inspection of nine campus modernization cases were recalled for discussion. Four informative tables were created that elaborate the most critical aspects on various campuses observed while adapting to interdisciplinary education, on the assumption that higher education institutes could be treated similarly on visionary terms.

In this section, the insights and outcomes are compiled from each institute's self-published strategic reports and financial statements, all reachable through their official websites. The main objective is listing the real life activities and promised activities declared by these prestigious organizations in search of making a positive impact or impose greatness in the higher education sector. The theme of each table and the sub-categories were defined in relevance with the suggestions addressed by the literature review. In an attempt, the extent of the concordance between published resources and the actual implementations regarding the change in modern tertiary education environments at an accelerating rate was inquired. Each table summarizes a different subject with a comparative attitude and each is illustrated with a list of definition beforehand, which stands for the clear definition of sub-categories and symbols encountered in the respective tables.

Limitations

Clearly, the subjective categorization of the provided data and the definition of themes in this work can stil be subject to different interpretations from varying perspectives. Besides, the limited choice of nine cases remains insufficient to define common continental/national conditions and regional codes to propose a universally acceptable framework, which is to assess modern learning environments. However, evaluation and data-oriented analysis reports submitted by international associations as well affirm the possibility of a common ground to manage the change, and what the higher education environments should consider for a feasible future.

Outcomes

This work ultimately purposes an interpretative and experimental approach to revise which organizational dimensions in the selected institutions have been prioritized in the last decade. Although there is a room for further and more systematical research in transformation of university campuses that revolves around interdisciplinarity, the final findings of this work might suggest an initial idea in the subject.

Selected Cases

The list of the selected cases are given here once again:

1.	**COVENTRY UNIVERSITY, Coventry, UK**
2.	**ERASMUS UNIVERSITY, Rotterdam, NETHERLANDS**
3.	**UNIVERSITY OF WESTERN SYDNEY**
4.	**AALTO UNIVERSITY, Helsinki, FINLAND**
5.	**UNIVERSITY OF EAST LONDON (Partner University), London, UK**
6.	**BROWN UNIVERSITY, Rhode Island, US**
7.	**CALIFORNIA COLLEGE OF THE ARTS, San Francisco, US**
8.	**UNIVERSITY OF CAMBRIDGE, Cambridge, UK**
9.	**UNIVERSITY OF SHEFFIELD, Cambridge, UK**

1. INSTITUTIONAL OVERVIEW

This dimension aims at providing a summarized image of the institutes by exhibiting their origins of foundation, efforts in creating public prosperity and common wellbeing, the type of administrative power division, and the activity level of construction or renovation works on physical assets.

List of definitions:	
Spec.	Abbreviation for specification.
No.s.	No clear statement of active presence.
CSR	Corporate social responsibility.
Institutional foundation	Origin of the institute. The foundation can be based on amalgamation of two or more long-existing educational institutes or groups.

- : Merger of two or more schools or colleges of different disciplines.

Societal impact	Volunteering in local community, corporate social responsibility projects in social justice and equality, access to education, public health and wellbeing, urban development, business, interdisciplinary innovation and sustainability. Corporate social responsibility (CSR) projects that provide robust community engagement alongside the opportunity for students and staff to gain recognition of the skills and knowledge.

- ✔ ✔ : Active social impact and community engagement projects in at least 5 themes.
- ✔ : Active social impact and community engagement projects less than 5 themes.

Administrative structure	Hierarchical arrangement of the authority. It determines how the roles, power and responsibilities are assigned, and how the work process flows among different management levels. Definition of task allocation, coordination, and supervision.

- **Bureaucratic structure (Bs):** levels of management based on hierarchy and merit. Decision-making authority through layers of rigid and tight procedures.
- **Functional structure (Fs):** employees become functional specialists by their expertise, which leads to operational efficiency.
- **Divisional structure (Ds):** composed of self-contained divisions that utilize a plan to compete and operate as a total or semi-autonomous center / department.

Territorial changes	Any kind of territorial expansion or additional physical facility realized on the existing campus site. Renovation and expansion works, research hubs/centers, informal mix-use facilities, technology or performance centers.

- ✔ ✔ ✔ : Many physical facility projects planned or executed on multiple campus sites simultaneously.
- ✔ ✔ : Many physical facility projects planned or executed on site.
- ✔ : Only one or just a few projects planned or executed.

	A. INSTITUTIONAL OVERVIEW			
	Institutional foundation	*Societal impact*	*Administr. structure*	*Territorial changes*
1	**In 1970** [technology, engineering, design].	CRS ✓✓	Bs, Fs	✓ ✓ ✓
2	**In 1913**.	CRS ✓✓	Ds, Fs	✓ ✓
3	**In 1891**.	No.s.	Bs, Fs	✓ ✓ ✓
4	**In 2010, dates back to 1841.** [Art & design, economy, technology].	CRS ✓✓ access to research infrastructures for external users*	Bs, Ds	✓ ✓
5	**In 1898**.	✓✓	Bs, Fs	✓ ✓
6	**In 1794**.	CRS ✓✓	Bs, Fs, Ds	✓ ✓ ✓
7	**In 1907**.	No.s.	Bs, Ds	✓
8	**In 1209**.	CSR ✓✓	Bs, Ds	✓ ✓ ✓
9	**In 1897.** [medical and technical schools].	CRS ✓✓	Bs, Fs	✓
Conclusion	The higher education institutes tend to hold a deep-rooted history	**An awareness of social responsibility and impact on the wider community.**	**Bs dominant, but not limited to.**	Most institutes actively update their campus environments.

Table 3-1: Institutional overview, referring to university history and campus structure inqured in literature review.

2. Pedagogy and Values

The pedagogical development and its conformity with the unique organizational vision manifest itself as the chief characteristics utilized to describe campus spaces and environmental design. The lifestyle and daily operational approach are as well defined by the common values and over time establish a specific institutional culture.

The highlighed attributes in each column indicate to the most stressed or frequently mentioned characteristics according to the vision and descriptions illusrated in the resources for the relative sub-category. However, the outcome contains the top three qualitative features based on the word repetition throughout the relevant sections in the statements.

List of Definitions:	
Education style	The prevailing characteristics that are frequently underlined in the institutional statements regarding the vision, common pedagogy and all educational operations carried out by the relevant responsibles.
Spatial traits	The characteristics that are manifested in physical facilities of the organization through renovation and modernization works or planning brand new campus spaces, in association with the vision definition.
Community culture	Description of the common values and adopted principles that are observed in the institutional community and their daily manifestations, its methods and approaches, valid behaviours, and guidelines.

Highlighted terms in the following table **(Table 3-2)** *show the most significant characteristics envisioned or actively adopted by the respective higher education institute on campus in general, and also on space renewal projects for modernization and development purposes. Information assumed according to web-based resources and official institute reports.*

**The rest of the characteristics* *were underemphasized when all the cases were put in a comparison between themselves.*

****(8)* *Numbers indicated in brackets in the conclusion row simply shows the total count.*

	B. PEDAGOGY and VALUES		
	Education style	*Principal spatial traits*	*Community culture*
1	*Student-centred Future-proof Community impact **Techology –led Research-oriented Employability-centred International engagement	Technology-enhanced State-of-the-art Sustainable Stimulating and engaging Multicultural Interdisciplinary Creativity Innovation New generation	Strong relationships with external collaborators Lifelong learning Enterprise and technology Open-minded Sustainability Internationalization Cooperation
2	Techology –led Individual growth Daring to ask questions, debate and discuss Future-proof Research-oriented Interdisciplinarity Community impact	Multifunctional Design-thinking Social validation Multicultural Interdisciplinary New generation Creativity and complexity Human-centred	Strong relationships with external collaborators Open-minded Colleaguality between campus actors Lifelong learning Sustainability Enterprise and technology Internationalization Active engagement
3	Student-centred Research-oriented Culture of constant discussion Collaboration Intellectually challenging Flexible and inclusive Strategical integrity	Technology-enhanced Multifunctional Stimulating and engaging Human-centred Interdisciplinary Innovative Informal Flexible Multicultural	Open-minded Strong relationships with external collaborators Colleaguality between campus actors Active engagement Innovation Cooperation
4	Collaborative Community impact Flexible and inclusive Employability-centred Research-based Interdisciplinary Culture of constant discussion Design Thinking	Human-centred Multifunctional Social validation Stimulating and engaging Sustainable Technology-enhanced Collaborative State-of-the-art Safety and security	Strong relationships with external collaborators Peer support and contact Lifelong learning Innovation Creativity Collaboration Integrity Colleaguality between campus actors
5	Research-based Employability-centred	Sustainable Collaborative	Innovation Colleaguality between

	Individual growth Community impact Culture of constant discussion Interdisciplinary	Accessible and inclusive Highly interactive Innovative Technology-enhanced	campus actors Lifelong learning Internationalization Reflection Active engagement
6	Innovative Research-based Equality Community impact Interdisciplinary Individual growth	Multifunctional Accessible and inclusive Human-centred Social validation Innovation State-of-the-art	Strong relationships with external collaborators Colleaguality between campus actors Reflection Internationalization Experimentation
7	Creativity skills Community impact Individual growth Problem-solving Innovative Interdisciplinary Collaborative Project-based Design thinking	Technology-enhanced Interdisciplinary Sustainable Collaborative Integrated Flexibility Multifunctional	Innovative Experimentation Multidisciplinary Strong relationships with external collaborators Equality and inclusiveness Internationalization
8	Complete experience Equality Community impact Research-based Individual growth Problem-solving Culture of constant discussion	Interdisciplinary Flexible & adaptable Collaborative Multifunctional Accessible Informal Sustainable Social validation	Colleaguality between campus actors Reflection Strong relationships with external collaborators Lifelong learning Internationalized
9	Techology –led Community impact Innovation Individual growth Collaborative Interdisciplinary Research-based	Innovative Collaborative Technology-enhanced State-of-the-art Flexible Accessible	Close contact with regional authority Colleaguality between campus actors Strong relationships with external collaborators Internationalized
Conclusion	***Research-based (8)** **Community impact (8)** **Interdisciplinary (6)**	**Technology-enhanced (6)** **Collaborative (6)** **Multifunctional (6)**	**External collaborators (8)** **Inclusiveness (8)** **Lifelong learning (5)**

Table 3-2: Pedagogical perspective, referring to educational pedagogy part inqured in literature review.

The last row ot the table, the conclusion of the presented attributes referring to the institutional resources, indicates in brackets the total repetition of the characteristics for the stated sub-category (education style, principal spatial traits, community culture). Only the most frequently mentioned three characteristics are specified at the end, in order to facilitate a simpler comparison between the literature review suggestions and the real cases. According to the screening of the resources, the most common pedagogical attribute among the selected cases have been research-based education, making an impact on the community, and an interdisciplinary attitude in teaching activities. First hand involvement in discovery and research-supported education has already been mentioned in both interdisciplinary pedagogy and deeper cognitive learning of the subject students (Frodeman, Thompson & Mitcham, 2010; Higher Education Academy, 2012; Pellegrino & Hilton, 2012; Evans, 2013; Olusegun, 2015). Moreover, the sense of purpose that serve for public wellbeing as well as the internal community ensures an amplified student engagement (Thomas, 2010; Deeley & Bovill, 2017; Duban et al., 2018).

Regarding the spatial characteristics, adequate incorporation of technology and digital tools and the collaboration-spurring organization of spaces outweigh the rest of the attributes. Multifunctionality follows the third most popular spatial trait in higher education environments. As STEM and STEAM programs propose learners an opportunity to experience an education process that benefits the science and technology in most relevant, connected and unitary way regardless of the nature of the major degree (Temple, 2008; Duban et al., 2018).

Finally, community culture of chosen institutions reveal a highly collaborative societal culture, for instance, to partake in joint research activities or common development projects with industry partners or local product developers for global benefits. Duban et al. (2018) states the fact that interdisciplinary pedagogy program enhances dramatically in collaboration-driven environments in education experience. This situation is affected by the administration structure thus decision-making mechanism of the institute as well (Kezar, 2005), as demonstrated in the next revision table. Inclusiveness principle, on the other hand, points out the equal rights, equal treatment to all and successful engagement of minority groups (ethnicity, background, cultural differences, lifestyle preferences etc.) or individuals with extraordinary conditions (particular medical conditions, difficulties in learning for innate reasons or disability to adapt etc.). Despite that inclusive community culture has not been underlined much in the examined literature scope, inclusiveness proves a critical criteria of a preferred higher education organization. Neither lifelong learning has not been widely recognized as a prevailing attribute. However, most of the given cases developed further education projects or courses through different means, by online platforms or certificate courses structured differently than standard major and minor degree courses. These prominently focus on skill acquisition, enhancement of employability and professional help for those in search of jobs in a specific field.

3. Key Concepts of Modern Learning Environments

In the application of evolving pedagoy and the integrated techological systems, the realm of higher education admits the academic and technical staff as the core of a successful team, and a pleasant community to work in. For that reason, an effectively functioning operation plan and conscious execution of educational activities in digital era fundamentally necessitate well-trained and informed employees whether being directly in contact with students or invisible to them in a non-academic department. To showcase the value this group represents for the feasible future of the university, the managers have to design the process of how to engage them in the latest learning technologies and teaching tools. Ensuring this requires an education and orientation plan to place the personel in the core of the main business – educational activities. The recent innovative methods in teaching and learning developed in a close relationship with cross-disciplinary movement that spread in education industry. Thus, these aspects decidedly affect the form of modern learning environments.

List of Definitions:

Staff training	Defines the success of a university. Comprises of: Building the capacity and capability of core academic and technical staff to achieve impact on the quality of all educational outcomes with efficiency. Enhancement of the employee conditions to become the best place to work. Pedagogic development and research-informed education, consultancy and partnerships for staff.

- ✓ ✓ ✓ : Prepared for ever-changing demands in an increasingly digital future, in a diverse and international environment characterised by intense and evolving demands. The academic faculty and professional services staff form a single community that creates positive societal impact together, each operating on the basis of their own individual expertise but as equal partners. Information packages, language courses, lecture series, cultural introduction social benefits.

- ✓ ✓ ✓ : Open discussions, awareness campaigns, and early identification by teaching faculty and mentors for student wellbeing. Incorporation of learning analytics and supporting staff understanding to use of data for evidence based decision-making about students' engagement with learning experiences. Equip and train staff in the use of these technologies to encourage innovation and efficiency. Provides teaching staff with the opportunity to pursue professional certifications and training. Sustaining initiatives to improve the climate among staff.

- ✓ ✓ : Stimulating and forward-looking leadership with clear objectives, feedback and motivating work for all university's employees. Improved control systems and efficient business processes within a culture of innovation and creativity. Bringing together research staff and the cultural and creative industries in the city, through a series of high-impact knowledge exchange partnerships.

Key innovations	Explain the strategic keywords and values adopted for becoming educational institutes as future-proof and flexible as possible in the face of changing trends, student and staff expectations and besides education quality standards. The organizational decisions will be foremost directed to the achievement of the stated principles.
Interdisciplinarity	The most prominent subjects on which to conduct associated research projects and produce knowledge through innovative approaches. Means to establish an interdisciplinary university-wide mentality.

	Staff training	Key innovations	Interdisciplinarity
		C. KEY CONCEPTS of MODERN LEARNING ENVIRONMENTS	
1	✓ ✓	Multicultural International Stimulating Virtual Digital Innovative Enterprise and social change incubation Sustainability-driven	International research collaborations, partnerships in novel cross-disciplinary fields with public sector and community. Multidisciplinary research. *In themes:* Pedagogy, Social prosperity
2	✓ ✓	Multicultural Enterprise and social change incubation Digitized Flexible Responsive Challenging contexts Sustainability-driven International	Interdisciplinary research and collaborations with internal and external actors. Open and responsible research in co-creation mode *In themes:* Social prosperity, Urban environment, Health and wellbeing
3	✓ ✓ ✓	Challenging contexts Digitized Responsive Sustainability-driven Flexible Supportive Enterprise and social change incubation Mix of formal and informal	Interdisciplinary research and collaborations with internal and external actors. Highly multidisciplinary learning experiences and incorporation of extra-curricular experiences. *In themes:* Social prosperity, Cultural awareness.
4	✓ ✓ ✓	International Stimulating Enterprise and social change incubation Sustainability-driven Innovative Challenging contexts Supportive	Transdisciplinary artworks and exhibition events. Interdisciplinary research and collaborations with internal and external actors. *In themes:* Energy solutions, Urban environment, Health and wellbeing
5	✓ ✓	Innovative Supportive Employment-directed Virtual	The Global Learning Futures: a progressive venture in interdisciplinary learning design and innovation across a multitude

		Friendly and respectful Flexible	of contexts. *In themes:* Technology, economy, environment, enterprise, health.
6	✓ ✓ ✓	Enterprise and social change incubation Challenging contexts Stimulating Innovative Sustainability-driven Mix of formal and informal	Interdisicplinary research in collaboration with internal and external departments and industry actors. Investigation of global problems. *In themes:* Environmental conservation, Social prosperity, Data science
7	✓ ✓	Innovative Stimulating Responsive Enterprise and social change incubation Multicultural International Flexible Sustainability-driven	Multidisciplinary studios combining the fine arts, design and architecture involving industrial collaborations. Transdisciplinary innovation. *In themes:* Visual Technologies, Urban environment, Financial impact of spaces
8	✓ ✓ ✓	Enterprise and social change incubation Flexible Sustainability-driven Virtual Stimulating Ergonomy and comfort	Interdepartmental research and collaborative research with commercial partners. *In themes:* Medicine & Biomedical, Physical sciences, Technology
9	✓ ✓ ✓	Stimulating Challenging contexts Enterprise and social change incubation Virtual Sustainability-driven	Interdisciplinary and translational research, collaboration with industry partners. *In themes:* Social prosperity, Urban environment, Wellbeing, Resource conservation, Energy and food
Conclusion:	Campus staff could be given more extensive opportunities to improve personally and professionally.	**Sustainability-driven (8)** **Enterprise and social change incubation (8)** **Stimulating (6)**	**Partnerships with external parties for common benefit (8)** **Environmental development (6)** **Social prosperity (5)**

Table 3-3: Refers to educational spaces and characteristics of interdisciplinary learning environments on campuses discussed in the literature review.

As learning is an organic procedure that is influenced by social and individual dimensions of humans, collective activities to constantly add value and update the students and teaching staff about pedagogic and institutional novelties is required (McLane & Dawkins, 2014). Implementation of interdisiciplinary processes eventuate through collaborations (Feller, 2002), for instance, partnerships of multiple universities or joint activities with industrial pioneers. Although, collaborative spirit should be founded in the community culture internally first, to be able to deploy any collaboration smoothly with external participants (Baalen & Karsten, 2007; Wilson & McCarthy, 2010). Since the sense of community and collaborative resolution have been consistently stated the very underlying elements of interdisciplinary and future-oriented university environments (Rytkönen et al., 2017; Schewenius et al., 2017), placing the staff to the center of educational operations might suggest an appropriate strategy to adopt generally, for tertiary education undergoing a change regarding its human asset asa well (Coulson et al., 2014; Wilson & Cotgrave, 2016). Fulfillment of diverse expectations and emergence of novel educational experience possibilities obligate university administration to recognize this challenging multiplicity and diversity of identities within the institution in terms of utmost effectivity and functionality. In accordance with the case study, literature confirms the significance of acknowledging internal client as primary client groups (students and internal employees) and allowing room for further professional improvement decided by self. Correct instruction of campus community, stressed once more, on how to embrace the transitioning implementations and benefit from the novelties to the maximum validates the positive outcomes that were planned (Neuman et al., 2013). In return, as interdisciplinary connection blends the domains of expertise through judicious procedures planned by the collaboration of learning investigators, the campus staff, the external society and university governing officials together, gatherings to educate the entire community initiate the first steps of an evolving culture towards increased collaboration and diminishing physical barriers inside modern facilities (Baalen & Karsten, 2007).

4. Management and Business Feasibility

Asset management and corporate investments, facility management and operations services, as well as stakeholder position in any big-scale corporation constitute the infrastructural foundation and role-defining mechanism, which govern the factors on the performance levels of the business. Reflecting on financial figures related to an institution's assets is preferred here, which are generally tied up in facility space construction job, since it could be an alternative approach to read the priority level of procuring modern and innovative spaces among other institutional expenses. Plus, the numbers are likely to correspond to the degree of involvement in multi-partner facility development projects as stated in subject university's strategic reports. Facility management practices on the other

hand, demonstrate the performance behaviour and the novelties that are being planned to introduce in the support services. Lastly, stakeholder engagement hints at how the institution perceives its diverse profile of customers in the context of information transparency, preservation of customer rights, consultation to the stakeholder opinion and fair return on their commitment to the business. These categories too provide valuable insights for this study.

List of Definitions:	
Built asset ratio to total assets	The total monetary value of the most recent investment expenses on modernization of physical facilities and equipment or on construction of new interdisciplinary spaces against the total built asset value. The ratio was chosen as an indicator of institutes' budgetary priority in spatial and environmental matters, for the purpose of inter-case comparison.
Strategic FM services	The organizational choices, their reasons and methods of operations and resources management from a narrow perspective of simple facility and real estate management practices. These decisions in FM service provision potentially reflect the unique stragety and vision of the institute about stakeholder inclusiveness, benchmarking and evaluation and user satisfaction studies.
Stakeholder engagement	The process by which an organization involves people who may be affected by the decisions it makes or can influence the implementation of its decisions. This element arguably represents one of the most important ingredients for successful service deliveries and return on collected feedback during stakeholder consultation and its subsequent evaluation.

- ✔ : Constant and regular participation of students, staff and alumni in improving the community productivity and satisfaction on multiple levels. Investigation of further development opportunities and gaps in the institutional operations program through stakeholder consultation: In-person seminars, workshops, public events, and web-based data collection inquiries are all effectively applied.

- ✔ ✔ : In addition to the condition above, the active implementation of accessibility and education options to wider community. Proper employment of lifelong learning principles, especially in areas of personal competence enhancement, collaborative and multidisciplianry research and social benefits. Definition of the achievement milestones and strategic decisions in participation with ranging groups of stakeholders.

- ✔ ✔ ✔ : In addition to two conditions above together, extended activities to favour both the professional and individual best interests of the campus community and the external stakeholders of any group. Transparency and accountability is assured at utmost level. Contribution and innovation with industry giants and governmental authorities for common wellbeing and social responsibility initiatives.

	D. MANAGEMENT and BUSINESS FEASIBILITY		
	New projects and the built asset value ratio	*FM strategy and audit services*	*Stakeholder engagement*
1	*Statement:* state-of-the-art campus. 77% : buildings and land, primarily investments in the Woudestein campus.	- Fast-paced and responsive financial and operational sustainability - Local: Quality Assurance Agency (QAA)	✔
2	*Statement:* an international campus through refurbishment and maintenance works. 80%	- Facility management, service and people management. - Local: The Dutch-Flemish Accreditation Organisation (NVAO)	✔ ✔
3	*Statement:* Progressive update of spaces for collaborative, technology-rich. 70% : properties, equipments and plants. Parramatta City Campus .	- Unification of all data management systems -Local: The Tertiary Education Quality and Standards Agency (TEQSA)	✔ ✔ ✔
4	*Statement:* Long-term campus development programme 28% : building and equipment asset. New commercial services and the new Business School.	- Integrating CREM practices, operational and financial planning with specific KPIs. - Local: the Finnish Higher Education Evaluation Centre (FINEEC)	✔ ✔ ✔
5	*Statement:* interdisciplinary developments. 55% : built asset infrastructure, improved technological systems.	- Robust information flow and regular reports by improved technological systems - Local: Edexcel, QAA	✔ ✔

6	_Statement:_ brand-new facilities (Medical School, Wellness Center, Arts Center, ''TRI-Lab''). 20%. Many projects realized by public-private partnerships. (=shared expenses)	- Risk and maintenance management, environmental conservation. - Local: The Association for the Accreditation of Human Research Protection Programs, Inc. (AAHRPP)	✓ ✓ ✓
7	_Statement:_ informal and common-use amenities, interdisciplinary studios and adequate infrastructure. 80% : campus enhancement and modernization.	- Spatial occupancy analysis, CREM and risk management for KPIs benchmarking. - International: The Association for the Advancement of Sustainability in Higher Education (AASHE)	✓ ✓ ✓
8	_Statement:_ infrastructure and common facilities. North West Cambridge development. 50%. Many projects realized by public-private partnerships. (=shared expenses)	- Internal and intra-sectoral KPIs benchmarking, risk and maintenance management in a sustainable manner - Local: Office for Students (OfS), QAA	✓ ✓ ✓
9	_Statement:_ new sports pitches, the new Social Sciences building, temporary teaching facilities, new engineering research buildings. 86%. Many projects realized by public-private partnerships. (=shared expenses)	- Change management, security and sustainabile energy technologies. - Local: Office for Students (OfS)	✓ ✓
Conclusion:	**Infrastructural investments** **Multi-use common facilities** **Research-leading facilities**	The universities must apply information technology and process management systems in facilities effectively, putting human satisfaction first in priority. Also, quality evaluation guidelines remain domestic in each location.	**High level stakeholder engagement, social impact.**

Table 3-4: The management methods, educational evaluation and regular assessment on facilities were brought up in the literature review's parts considering management solutions and environmental assessment tools.

Financial policies play a critical role in financial risk management and investing opportunities for further development in higher education organizations. An ideal university financial management provides stability to the institution, allows for investment as well as renewal and the exploitation of material opportunities, be transparent enough to facilitate accountability and good governance, and ensure that the institution allocates resources efficiently in the context of its strategic plan (Taylor, 2013). With respect to this fact, property and built asset to total asset ratio is taken as a measuring tool to crosscheck the university strategies that expound ambition in facility modernization and built asset investments to found new generation workstations that mitigate interdisciplinarity (Lindvig, Lyall & Meagher, 2019). In addition to this consideration, infrastructure arrangements within modern facilities shall be upheld for optimal performance by means of facility and real estate management services (Rytkönen, 2016). Thus, it is partially verified that an exceptional performance level in the educational organization results from the co-dependance between management best practices and facility performance regarding specified objectives. Besides, facility management promotes an eased transformational change as well, that occurs in higher education environments in the last decade at an accelerated trend (Riley, Kokkarinen & Pitt, 2010). Literature review suggested a well-developed study called 'Learning Landscapes' project, as an alternative method to reaffirm the idea that disciplinary boundaries cause misinterpretation of missions and fragmented network of duties. Therefore, contemporary campus management aims for the involvement of all campus members through a conversation (Neary et al., 2010). Interdisciplinary approach across campus exhibits an uplifting impact on the administration and overall performance, suggested the resources, and the case study approves this suggestion as well.

5. Findings

1. The universities that are recognized for their successful transformation facing the changes over time happen to be mostly the long-established institutions with a solid community and tradition. Their long history, organizational flexibility and experience of managing the change successfully might be the reason of the capability in effective integration of interdisciplinarity into practice. This fact remains valid despite the contradicting finding that reveals most university hierarchy structure have remined a heavily bureaucratic.

2. Constant spatial and infrastructural upgrades in campus environments responding the altering demands is a common feature of effectively interdisciplinary universities.

3. Extended and diversified opportunities of individual improvement neeed for internal campus stakeholders.

4. The most remarkable innovations on space modernization have been the creation of engaging atmospheres covering recent themes such as enterprise incubation and interdisciplinary research problems, supported by sustainability-concordant elements.

5. Industry-university partnerships contribute greatly to the consolidation of interdisciplinarity in higher education domain, therefore, enhancing the overall social development.

6. Refurbishment of underlying infrastructures and spaces reserved to novel research activities regardless of the disciplinary departmentalization in the institute.

7. There is definitely a lack of universal agreement on neither applying nor assessing the quality and feasibility of interdisciplinarity principles on higher education organizations that undergo a modern transformation as required by 21st century.

8. Campus community including both the internal and external stakeholders becomes more important for universities day by day, since social impact and corporate responsibility act towards wider public has been recognized as a natural payback of the existence of higher education institutes.

Results:

What works:	What needs to be worked on:
A solid community culture and tradition	Embracing the change
Responsive attitude in space renovation	Subjectivity and topicality of the definition in ''what is interdisiplinary''
Opportunities of individual improvement	Awareness of the deep connection of higher education and the global society
Industry-university partnerships	Discovery of underused or outdated spaces and resources as an opportunity
Situation-fit IT management systems	

What needs to be worked on column demonstrates the main problems that are probably being overlooked or neglected by university authorities, which undermines a potential progression of the campus culture and facilities and modernize due to interdisciplinary elements.

What works column, on the other hand, affirms the strategies that are seemingly favouring to the enhancement of interdisciplinarity in higher education sector and development of clear guidelines in its control.

Results and Conclusion

The research problem was broken down into a number of logically articulated parts, which represent different aspects of interdisciplinarity as a consolidative and complex method of development in higher education environments. By means of literature review, a befitting approach to distinguish the underlying impact factors of the adaptation of cross-disciplinary orientation on campuses was laid out appropriately. The whole revision and research process progressed in three interrelated and continuous phases: Section 1: Literature Review, Section 2: Multiple case study, Section 3: Discussion tables of quality features of the former. This holistic approach enabled an analytic but interpretative understanding of each potential impact factor within its unique and divergent setting.

1. Adressing the statement and the research question

Interdisciplinarity has been considered a crucial subject on educational environments and campus evolution. Besides, the newborn industry fields and global issues, that are mostly involved in cross-disciplinary interfaces, entail the development of innovative partnerships between corporate and academic bodies for common welfare. For that reson, rather than formal long-stood teaching formats, peer-to-peer learning and education through interdisciplinary collaboration will presumably dominate the higher education scene. What are the elements that generate successful interdisciplinary learning environments in devotedly satisfactory higher education institutes? Research coherently showed that there is no unique impact factor to stimulate interdisciplinary university environments, neither could be formulized a specific program to it with concrete and accurate stages. The analysis and comparison of the collected information showcased rather an interconnected network of variables –impact factors, which can be employed for precise outcomes in the chosen aspect of decision-making. Moreover, by means of the co-dependance of multiple impact factors in higher education ecosystem, institutes may recruit these interrelationships in order to develop an organization-specific tool of quality and performance standards. However, many common features of outstanding higher education environments have been determined to form an impression of the elements that induce high-performing and interdisciplinarity-oriented facilities. Thus, the results of this study can simply suggest where to concentrate the attention and efforts of interventions to tertiary education facilities that aim for a well-sustained modern and interdisciplinary environment to its community in the face of rapid change.

Findings regarding all three sections are synthetized in Table3-1, where the highlighted words in red indicate the overlapping findings from all three sections regarding the subject statement.

Table 3-1: The summary and synthesis of the findings across three sections.

Section no.	Findings
Section 1: Literature Review	Higher education environments will keep evolving on various levels (digitization, pedagogy, economy etc.) Peer-to-peer learning and education through interdisciplinary collaboration will dominate. Organizational values, vision and strategic approach plays a key role in determination of the overall success level. Implementation of whether collegiality-equality or pecking order between campus actors determines the sense of belonging, thus engagement and satisfaction level of students. Deep-learning is achieved through experiential, situated, partially customized and student-centred education. Interdisicplinary education is necessary to raise capable, confident and collaborative individuals in alignment with today's novelties and skill requirements. Evaluation, reflection and corresponding action are fundamental for enhancement. Space transforms learning experience into socially interactive knowledge with consolidation. Socialized learning and networking manifest themselves in the new generation educational mediums. Time dedicated in tertiary education spaces and learning process are seen as a preview of future employment. Plus, lifelong learning has been validated by abundant opportunities (self-teaching, evening or online courses).
Section 2: Case study analysis	Interdisciplinarity = sociability + sustainability + innovation + inclusiveness Through the creation of informal, social and physically adaptable campus centers based on modern student and staff needs. The outcome is a collaborative and dynamic community where wellbeing and learning experience is valued the most.

Section 3: Discussion tables	A solid community culture and tradition
	Responsive attitude in space renovation
	Opportunities of individual improvement
	Industry-university partnerships
	Situation-fit IT management systems
	Embracing the change
	Clear definition of an interdisicplinary vision

2. Contribution and results

By means of three-staged comparison development, this work provided an insight to the differences and similarities between written resources and actual applications in real higher education organizations regarding interdisciplinary environments.

The Section 1 of literature review made an introduction to the subject of interdisciplinary and modern learning environments in higher education systems. First of all, the review addressed the impediments and limiting conditions that have existed despite the changing era along with social relationships, digital proficiency and dissolving boundaries between certain distinctions: isolated and disciplinary departments, heavy bureaucracy, inefficient and excessively branched decision-making mechanism of expanding businesses, late recognizance of personalization and acquisition of content, failure to define a clear development program its implementation for varying reasons, and creating a committed community out of individuals. All elements were mentioned within the problems that universities have to face in modern times that requires agility and flexibility. The impression resulted in the stipulation of five thematic indicators for a more organized multitude:

1. History of the higher education institute
2. Pedagogical changes
3. Spaces and spatial characteristics
4. Facility management in higher education
5. Evaluation and assessment

Section 2 on the other hand served as a ground to delve into selected cases, provided in identity-like tables, each chosen because of the modern construction or renovation project given next to their name. They are all organized in regards to the information gathered in Section 1. However, at this stage, some data was strained off to keep working with, while not stressing the parts that looked of secondary-importance for the sake of the research (subjective choice to some extent, since it is based on personal impression).

Interdiscipliarity-related statements and information were prioritized in these detailed tables, from where deeper relationships between interdisciplinarity and other impact factors could be extracted for the investigation of baseline indicators. Images from each case were provided as well, in order to help the reader observe the institute's vision by looking at the latest project of interdisciplinary-use facility.

In conclusion, Section 3 re-arranged evaluation tables based on modified categories, which are divided into smaller-scale impact indicators. In the end row of each table, the results elaborate the listed indicator characteristics, through either the mean value of all the cases if the measurement is quantitative, or the most frequently referred characteristic if it is qualitative. When there was a correspondence in the literature review to the results, the interpretation given underneath referred to it as a re-affirmation to strengthen the respective argument. Several impact indicators were represented by check-marks, with the purpose of converting the indicator value from qualitative into a representative quantitaive measure for simplification reasons. Thus, one check-mark corresponded to 1 point, totaling to either 2 or 3 the most, depending on the internal variety range of an indicator. Section 3 provided four evaluation tables, each presented with unique list of definitions to clarify the particular markings and pre-defined impact indicators.

The results of the study, within its limited perception, demonstrate a substantial alignment of the indicators asserted by the literature review, case study interdisciplinary overview and re-evaluation of correspondent impact indicators in the scope of the available knowledge of the real statements and reports of all selected higher education institutes: (1) Research and technology-driven, (2) unified community with an inclusive and collaborative culture, (3) multi-use and socially engaging spaces, (4) active presence in social responsibility and public impact projects, (5) administrative and operational flexibility and agility. On the contrary, two most encountered statements about interdisciplinarity-impeding obstacles were discerned as the insufficient incorporation of or non-existent facility management principles among higher education organizations, which leaves the performance and assessment measures deprived of regular and orderly data collection. The second obstacle emerged as underused assessment techniques that would be specifically designed to fit purpose. For instance, higher education quality standards auditing or evaluative tools such as POE (post-occupancy evaluation) which could uncover underperforming areas and sources of user dissatisfaction. As an additional note, partnerships in construction of new research facilities and learning centers can become a more widespread behaviour, for its positive effect on both side's financial expenses and risk share, as well as an increased interaction between different user segments in a joint atmosphere that catalyzes innovation according to the research. Eventually, the results conclude with findings that are general enough to be able to applied universally, without the likelihood of violating any local code or cultural totality.

Limitations

Throughout the process the research faced limitations such as narrowed or potentially subjective definitions, and baselines for further assumptions during progress. The classifications made to develop a stagewise approach in Sections 2 and 3 were decided with respect to the literature review in the first section, although this might not constitute a basis objective enough. In addition, the scanning procedure of the case universities reports and statements too may have remained constrained, for which some information could be gone unnoticed or publicly non-available for researcher's access. Also the locations and national systems of higher education of selected cases is a limiting factor, which could be overcome by expanding the investigation through inclusion and analysis of more cases of deliberate selection. To explicate, the study contains cases mostly from the UK, given from another perspective, mostly English-speaking nations even when cases outside the UK included. Therefore, in assumption of a similar study would be conducted in a multinational and multilingual framework across several different nations, unavoidable translation discrepancies in language or cultural terminology would be encountered as further limitation factor. Even the creation of an increased variance of indicators could have been needed for administrational and regional differences in human dimension and business operations.

3. Conclusion and final thoughts

As the conclusion of all findings agrees, interdisciplinarity develops based on a multitude of diverse changes the society undergoes, including social values, responsibility upon sustainable manners, economical priorities in the world of business, achieving the highest possible efficiency rate in production and innovation. For that reason, higher education institutes have to follow up on these changes in order to remain competent to educate the community. The underlying circumstances that would satisfy this qualification prove to be a regular and systemized evaluation and conformity assessment with the present needs of the society of the actual times, performed in university facilities and campus sites. The results of this work suggest that universities have to upgrade their strategies and vision of spaces, pedagogical methods, technological strength on the performance of operations; as well as favour to user demands more extensively and critically. Only then higher education institutions will be able to improve organizational flexibility and ease the resistance to constant change that happens in the outer world. The tradition and culture, although seen as the backbone of consistency, reputation and durability facing decades, must leave a certain margin of tolerance which allows future-proof advancement and modernization given the underused spaces, as well as wasted resources and unnoticed opportunities of improvement. Thus, positive criticism and acceptance of change would make the difference.

Moreover, higher education facilities and campuses will continue to play an essential part in creating unique communities of intellectual and social knowledge, encouraging them to think critically, and helping them to build links to the outside world, despite the increasing domination of digital tools for fundamental learning activities. The shift in the technological

inventions, newly introduced modes of working, and living to the society and connectedness of all these has been at such a fast pace that many universities have not yet been able to match. A campus environment is a collective place where knowledge, businesses, and investors, lifelong learners, and researchers gather, where its students immerse themselves intuitively into discovery. Therefore, a university campus that strives to manifest its institutional vision, the belonging facilities might spatially express these values and the community culture by means of the physical environment. As the new generation university environments have already started to embody the time's demands, such as mix-use of formal and informal spaces or blurring cross-disciplinary boundaries, further investigation should be performed to a wider extent to ascertain more opportunities for the enhanced level of responsiveness before future changes.

4. Further development of the research

This study collected literature knowledge and critically compared the various indicators extracted from the review to the selected cases of intervention in modern higher education environments that lead innovation and interdisciplinarity as a mission. However, the reduction of discrepancies in the definition of interdisciplinary norms and innovation based on the scope of institutional types and codes would bring several improvements to the study.

The limitations of literature review resources might have omitted possible other characteristics concerning the compliance check of such environments with what is really needed in practice. Hence, further examination of feedback reports and regular post-occupation evaluations might help determine the quality aspects more precisely in the modernization higher education institutes. The qualitative findings could be analysed and reassessed through widely-accepted evaluation methods in the relative study field to put them in trial with real users. By this means the effective characteristics suggested by the literature could be compared to authentic feedback and shortlisted as a set of effective performance indicators or regulation codes. In consequence successful creation of standards and performance management in higher education campuses can be achieved with greater outcomes.

The results would be more extensive and accurate if, for instance, the organizations subject to this research were somehow classified according to their visionary development regarding the future needs that disciplinary amalgamation and flexibility options in spaces call for. Nonetheless, each institute or campus culture will have its codes and long-established strategies and objectives, or internal system of practices. These would definitely vary from institute to another in terms of applicability and feasibility considering the unique contexts and perspectives. Thus, the focus area to be improved in *campus A* might be significantly diverse than that in *campus B* regarding physical environments and how to develop an integrated solution of interdisciplinarity and modernization within them.

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