*Article*

# Prototype Development of a Cross-Institutional Credit Transfer Information System for Community College Transfer Students

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**Abstract:** Credit transfer information systems in higher education are not well studied. This article demonstrates the prototype development of a cross-institutional credit transfer information system (CICIS) for community college transfer (i.e., vertical transfer) students in an Asian educational context. It exhibits credit transfer guidelines and past credit transfer records to enhance the transparency and sustainability of credit transfer information and to facilitate the transfer process of prospective community college transfer students. It also ensures the sustainability of credit transfer information and its application. The four-phase life cycle of the prototyping model was adopted to guide the study. In this paper, we report the first three phases of this development: (1) Users' needs assessment and pre-prototyping groundwork, (2) prototype development, and (3) unforeseen circumstances and expert review. Challenges and difficulties throughout the whole process are documented and discussed. Based on this prototype development experience, a solid foundation of strategies for future engineering and enhancement of credit transfer information systems can be developed.

**Keywords:** credit transfer information systems; credit transfer practice; credit exchange; information system development; community college transfer students; vertical transfer

## 1. Introduction

Education is an institutionalised way of keeping ideas, knowledge, and skills sustainable, where higher education institutions serve as one of the main gatekeepers. The massification of higher education has popularised community college transfer (i.e., vertical transfer) as an alternative route to baccalaureate studies, leading to an expansion of the transfer student population in the last decade [1,2]. The landscape of higher education has seen better democratisation and sustainability of opportunities and resources to individuals of various ethnic, socio-economic, and educational backgrounds. The growing proportions of vertical transfer students in universities have led to calls for institutional actions to address and meet the needs of these students [3,4]. The transfer is often described as a "turbulent" pathway owing to the highly complex process of transitioning and adjusting from the sending institutions (e.g., community colleges) to the receiving ones (e.g., universities [4–11]). This route to baccalaureate studies is, as mentioned, also commonly known as vertical transfer, through which students completing their studies in a two-year community college can articulate to the third year of a bachelor's degree programme in a four-year university [12]. Meanwhile, horizontal transfer typically refers to the path of students

changing from one four-year institution to another, which is irrelevant to this study. We focus on vertical transfer, and in particular, vertical transfer students (hereinafter "transfer students") who are the graduates of community college holding an associate degree or a higher diploma.

When progressing from community college education to baccalaureate studies, students have to face transitional needs, including going through articulation [13], which is the process of formally defining how course credits and/or programmes earned at a student's previous institution (e.g., a community college) can be applied towards credits and/or the degree at the receiving institution [14]. It has been suggested that institutions should actively develop and promote policies and practices to cater to transfer students' needs relating to credit transfer [15–17]. The foremost impact of effective articulation for transfer students is to move from one programme to another without repeating learning (i.e., taking similar courses) [18]; this is attainable through effective credit transfer practices [19]. When more of their pre-transfer credits are accepted by universities, their study loads can be reduced [10,20]. The resulting higher likelihood of degree attainment is the aspiration of many community college and transfer students [21]. In turn, given the increased accountability pressures on universities, this degree attainment rate serves not only as an important student outcome but also a pivotal institutional performance measure [22,23]. Advancing from organisational actions to national effects, effective credit transfer contributes to the efficient use of an institution's share of resources, fostering the atmosphere of higher education [24].

To improve and sustain the strategies and practices relating to credit transfer, technology can play a ground-breaking role [25,26], especially in this information age when the internet serves as the foremost source of information in the credit transfer process [27,28]. Higher education institutions have been collecting huge volumes of student and learning-related data from self-reports and student information systems for facilitating both academic and administrative processes [29]. From the students' perspective, they typically carry out online searches of detailed information that help them to apply for credit transfer, such as lists of eligible courses [30]. Clear and readily available information is crucial for facilitating the credit transfer process and improving the overall transfer experience [27,30]. In fact, the information can also help community college students (i.e., prospective transfer students) to make informed decisions about opportunities for transferring to university [31]. Secondary school students also need this information if they are considering these "non-linear" post-secondary pathways to baccalaureate studies [32]. Nonetheless, the accuracy, currency, and presentation of transfer-related information from institutional websites are not always well received [27,33–35]. For example, it is typical that discontinued programmes are still displayed on websites of universities and community colleges [33]. Students have also complained about the large amounts of time needed to rummage through institution-level and department-level web pages in order to locate relevant information such as articulation agreements and credit transfer policies [36,37].

It is recommended that, to sustain the process and provide accurate information for making decisions about course enrolment and credit transfer applications, community colleges and universities co-establish online locations as deposits of transfer-specific information [15,38,39]. These online systems can be developed domestically by institutions, vendor-supplied products, or a mixture of both, functioning as an online catalogue of credit transfer related information [24,25]. As detailed in the next section, a few online platforms and information systems to facilitate credit transfer have been established in Canada, Europe, and the US over the past three decades. However, the process of the development of these systems has not been published. The literature also reflects the inadequacies of previous studies in this area in the past decade. Nonetheless, given that community college transfer also prevails in Asian countries and regions (e.g., Malaysia, Mainland China, and Hong Kong) [5–9,40]), there is a lack of research on credit transfer information systems, particularly in Asian educational contexts. This study attempted to fill the knowledge and research gaps by describing our work in designing and developing the prototype of a credit

transfer information system in Hong Kong using the four-phase life cycle prototyping model, and reporting the issues and challenges encountered throughout this process. It is our hope that, by expanding research on credit transfer information systems through a detailed account of system development and extending the literature from Western to Asian education contexts, this study not only improves the sustainability of developing credit transfer information systems as an essential tool to facilitate higher education, but also draws the attention of various stakeholders of higher education to the needs, benefits, issues, and possible solutions associated with the development process.

## 2. Related Works

### 2.1. Literature Review of Credit Transfer Information Systems

An information system is defined as "an organised set of resources which allows [users] to collect, sort, classify, treat and transmit information" in a designated environment [41]. In the context of higher education, the seamless flow of integrated information, as enabled by an information system, can save the time and effort of academic staff who can then focus instead on their research and teaching [42]. Skoumpopoulou [43] conducted a systematic review of 54 conceptual and empirical studies on information systems in the higher education of Australia, the UK, and the USA (i.e., Western educational contexts), which were for academic administration purposes such as enterprise resources (e.g., human resources and accounting) planning and warehousing student information. Despite the growing popularity of researching transfer students in recent decades, none of the reviewed studies focused on information systems for credit transfer or articulation. Nevertheless, the idea of a system with credit transfer information does exist. It has been labelled differently in the literature, including "credit transfer system" [44], "credit transfer and accumulation system" [45] or "credit accumulation and transfer system" [46], and "credit transfer information system" [36].

In essence, a credit transfer information system gives a "customisable view of programme and course information" and also personalised transfer pathways [25]. Existing papers and reports have introduced multiple objectives of these systems. First, successful credit transfer facilitated by these systems promotes the recognition of students' prior learning, in terms of both their academic and professional training [47]. It also radically reduces transfer students' workloads and thus improves their learning experiences [48,49], due to a reduction in overloading that has been a long-standing issue in the transfer student literature [5–10,50]. At the same time, information gathered on these systems, such as records of credit transfer, helps to enhance the transparency, comprehensibility, and sustainability of the credit transfer process [51]. Subsequently, student mobility between different study programmes and institutions can be enhanced [48]. With these systems implemented, flexible cross-institutional methods can be devised for recognising accumulated credits earned in various education settings [52], and hence better connections and partnership between institutions can be built and sustained [26,53]. In other words, these credit transfer information systems act as a "catalyst for inter-institutional cooperation" [25]. In the long run, when the mechanism and process of credit transfer mature, the architecture of higher education can be harmonised [47]. In addition, the datasets gathered and organised in these systems can be exploited for research and administrative purposes [54,55]. In particular, Educational Data Mining (EDM) and Learning Analytics (LA) technologies have been applied to collect, analyse, and visualise student and learning-related data from information systems [56]. EDM and LA studies commonly take advantage of, for example, student admission data for predicting students' academic performances and designing early interventions [57–59]. Nonetheless, these systems have also been criticised for causing institutions to bear extra time and financial costs in assessing prior learning, administrative support, and the "hidden costs" of resistance shown by academic staff [60]. Consequently, the development of these systems can be very limited or fail to catch up with the rising trends of community college transfer [36].

*2.2. Existing Credit Transfer Information Systems*

A well-documented example of a cross-institutional credit transfer information system is the European Credit Transfer and Accumulation System (ECTS). Starting out as a pilot project of the European Commission involving 145 institutions, and one of the highlights of the Bologna Process, the ECTS is a "student-centered system for credit accumulation and transfer based on the transparency of learning outcomes and learning processes", aiming to "facilitate planning, delivery, evaluation, recognition and validation of qualifications and units of learning as well as student mobility" [47,61,62]. It has been linked to the structural reform of European higher education systems [60]. Being implemented across European nations, it has been regarded as the "European credit information system" [63] and has helped to establish a "blueprint" for the European standard framework of credit accumulation and transfer (CAT) [47]. The ECTS is, nevertheless, perceived by some institutions as an activity that is "peripheral" to higher education [44], rather than being mainstream or "core business" [46], and is even regarded as a "bureaucratic exercise" with minimal impact on practice [44,47,60]. This perception is related to institutional culture that can be ingrained and rigid even with the pressure from legislative initiatives or external evaluations to change [64] and that, by itself, would likely discourage changes or such new initiatives as employing the ECTS [54]. Therefore, effective planning and implementation of a credit transfer information system needs to be not only compatible with the existing educational systems but also non-invasive with regard to institutional policies [43,47].

Another example is the Articulation System Stimulating Interinstitutional Student Transfer (ASSIST), https://assist.org/, (accessed on 24 June 2021) a student-centred initiative for facilitating the credit transfer process in the Californian public higher education system, providing students and faculty with "information on what courses at one community college or university can be transferred to a specific programme at another college or university" [51]. Having launched a new interface in May 2019, ASSIST offers a clear transferability list and articulation agreements between public institutions in California. In British Columbia (BC), the British Columbia Council on Admissions and Transfer (BCCAT) established the online BC Transfer Guide, https://www.bctransferguide.ca/ (accessed on 24 June 2021), to host course and credit equivalencies and formal transfer agreements in the post-secondary systems within BC [65]. There is also a state-wide Ontario Council on Articulation and Transfer (ONCAT) database, https://www.ontransfer.ca/ (accessed on 24 June 2021), serving to "improve transparency and access to information about pathways and credit transfer", thereby promoting transfer student success [54]. In Hong Kong, there is also a centralised database of CAT information and credit transfer arrangements in the Qualifications Register, https://www.hkqr.gov.hk/ (accessed on 24 June 2021), launched by the Hong Kong Council for Accreditation of Academic and Vocational Qualifications (HKCAAVQ). Its data are nonetheless limited and not granulated, displaying only general credit transfer arrangements and programme-to-programme articulation pathways.

These credit transfer information systems are, however, reported to be unpopular with or even unknown to some students [66]. This can be attributed to the lack of public promotion and stakeholder awareness of institutional policies and practices that support credit transfer, as reported by a comprehensive literature review of the credit transfer practice in the majority of English-speaking countries [60]. In addition, it remains unclear how these systems were initially developed. Involving different stakeholders of higher education during the system development might improve the efficiency and efficacy of the system. While extant research and documentation have covered credit transfer information systems (CTIS) in Western educational contexts, Hotta [67] conducted a meta-analysis of credit-related systems in 24 Asian countries and regions, including Malaysia, Singapore, and Hong Kong. These systems were aimed primarily at improving international (i.e., cross-country) student mobility and none of them catered for community college or vertical transfer, despite the prevalence of this pathway in some Asian educational contexts [5–10,68]. Systems for credit transfer in Asia tend towards facilitating international exchange programmes and accommodating undergraduate students' international mobility [69].

## 3. Theoretical Framework

The idea of building an information system for facilitating credit transfer and articulation is driven by the theories of transfer student capital and transfer student success. Transfer student capital refers to the experiences of community college students transferring to universities, indicating that to negotiate the process of transfer, they accumulate knowledge and understanding such as credit transfer agreements between institutions and course prerequisites [70,71]. For prospective transfer students in a community college setting, looking up information about potential transfer institutions and preparing proactively for the transfer process are important actions for accumulating transfer student capital [72]. When students gather and make sense of information about transfer, they might develop self-efficacy that can motivate them along the transfer pathway and eventually lead to academic success [73], as part of transfer student success that is often operationalised as academic performance and degree attainment in universities [4].

## 4. Research Context

### *4.1. Community College Transfer in Hong Kong*

In Hong Kong, there are two routes to government-funded bachelor's degree programmes offered by eight public universities, namely post-secondary admission and community college transfer. Starting from 2000, when the American community college model was pioneered in Hong Kong, those who fail to fulfil the entrance requirements on the public examination results can choose to enroll in local community colleges. Since 2000, there have been an increasing number of self-financing post-secondary institutions delivering a diversity of associate degree and higher diploma programmes; as of 2020, 26 sub-degree institutions (i.e., commonly known as community colleges in the literature). An associate degree (AD) or a higher diploma (HD) qualification (collectively known as "sub-degree" in Hong Kong), along with a competitive grade point average (GPA), is mandatory for transferring to baccalaureate degree studies in a university. Unlike their Western counterparts, vertical transfer students are normally expected to complete their sub-degree studies in two years in full-time mode, comparable to the junior and senior years of native university students. It is also noteworthy that vertical transfer students in Western countries are more demographically diverse while the students in Hong Kong are largely fresh graduates from community colleges ([74]). The procedure and process of credit transfer are institution-specific, i.e., varying from institution to institution. In general, there are three types of credit transfer: subject-to-subject, programme-to-programme, or a combination of the two, depending on the articulation arrangements between sending and receiving programmes.

### *4.2. Development of a CAT System in Hong Kong*

As early as 2002, in light of the policy target of higher education expansion, the creation of a CAT system was recommended by the University Grants Committee to facilitate student mobility after the in-depth review of the landscape of higher education in Hong Kong [75].

Aiming to provide degree aspirants with clear progression pathways, the Hong Kong government introduced the idea of the Hong Kong Qualifications Framework (HKQF) in 2004 and implemented it in 2008. This was underpinned by the HKCAAVQ in its statutory role as Accreditation Authority. HKQF is a unified quality assurance body that establishes a comprehensive network of learning pathways, thereby encouraging and facilitating the individuals in their educational planning and pursuits, and promoting lifelong learning in Hong Kong. It also oversees the post-secondary system with quality-assured qualifications and defines the clear articulation ladders between different levels of qualifications among academic, vocational, and continuing education sectors [17].

It was expected that the development of HKQF would offer a common platform and benchmark to facilitate CAT arrangements between sectors and between providers of educational and vocational training [16]. However, the CAT system was criticised in a

statutory review report for not being well established [16]. In particular, there was no clear information about articulation arrangements for the public to access. It was concluded that a more integrated platform providing students with transparent and trustworthy progression pathways and CAT information was necessary to accommodate the rapid growth of post-secondary systems in Hong Kong [16].

### *4.3. CAT Database in Hong Kong*

In 2014, the policy and principles for CAT under the HKQF were promulgated by the Hong Kong Education Bureau (EDB) to further strengthen the support for mobility in higher education [17]. The CAT centralised database was established on the Hong Kong Qualifications Register (HKQR), which was launched in late 2018. This is a centralised information centre consisting of quality-assured and statutorily-recognised qualifications under the HKQF. Notably, the CAT information is uploaded by institutions on a voluntary basis, thus leading to the possibilities of gaps, outdatedness, and inconsistencies in this information.

The HKQR is intended to be a searchable web tool for CAT information and articulation arrangements. However, owing to the limited supply of CAT information from institutions and the display of only general articulation arrangements, its helpfulness is limited. Empirically, only 40% (n = 3198) of all (n = 8009) current qualifications on HKQR carry CAT information [76]. Moreover, information about programme-to-programme articulation shown on HKQR is largely generic and incomplete, with only 6% (n = 194) of the qualifications containing programme-level information. These shortcomings would undermine the sustainability of CAT information.

### *4.4. An Ongoing Cross-Institutional Project*

The experience presented in this paper is part of a cross-institutional project aimed at enhancing the learning experiences of community college transfer students in Hong Kong and beyond. It was conducted in a local public university (hereafter referred to as University A) hosting the largest number of community college transfer students in Hong Kong, in collaboration with three other local public universities (hereafter referred to as Universities B, C, and D). The project team comprised academics, professional consultants, research staff, and project personnel, assisted by administrative and technological support staff from the four participating universities. A major deliverable of this project is an information system that exhibits credit transfer guidelines and the past credit transfer records in the four participating universities. Its main goal is to enhance the transparency and sustainability of credit transfer information and to facilitate the transfer process of prospective community college transfer students.

## 5. System Design and Prototype Development

The system design and prototype development were guided by the four-phase life cycle of the prototyping model [77,78], which is deemed suitable for developers without a high level of technical expertise [79]. In the first phase of this model, an assessment of the main stakeholders' needs was conducted to inform the design of the system. In the second phase, a prototype of the system was built based on these design decisions. In the third phase, the prototype was evaluated by experts and lay users to elicit comments and suggestions for refinements and revisions. The fourth and final phase marked the engineering and release of the product (i.e., the cross-institution credit transfer information system (CICIS) in our case). In this paper, we report the first three phases of this project.

### *5.1. Phase I: Users' Needs Assessment and Pre-Prototyping Groundwork*

5.1.1. Needs Assessment

Government Policies on Sending and Receiving Institutions

According to a report published by the University Grants Committee in 2010 [16], following an increase in the number of sub-degree programmes (i.e., associate degree and

higher diploma) and hence of vertical transfer students in Hong Kong, a robust system should be adopted to make clear the pathways for student progression in post-secondary education. In the Code of Good Practices on Governance and Quality Assurance for self-financing post-secondary institutions (e.g., community colleges), it is also recommended that students should be provided with clear information for their application and admission to degree programmes, including but not limited to credit policies and articulation pathways [80]. In July 2014, the EDB announced the set-up of policies, principles, and operational guidelines for CAT in post-secondary education [17]. Similarly, there have been scholarly recommendations about the development of a CAT system for tertiary institutions in Hong Kong [81].

Recall of Experience from Current Transfer Students

The availability of and access to credit transfer information are pre-requisites for transfer students' pre-transfer (e.g., choice of degree programmes) and post-transfer (e.g., workload) decision making [60,82]. In-depth focus group interviews with transfer students were conducted from February 2018 to December 2019 to gauge their information needs in the four participating universities. In total, 296 transfer students, representing most disciplines and years of study, joined the interviews. Since the main target users of this system are community college students and transfer entrants to university, we asked the interviewees to recall their transfer experiences. They recounted several challenges in their experiences of acquiring information related to articulation and credit transfer. They addressed the importance of having more information to enable them to make better study plans at both the pre-transfer and post-transfer stages. However, according to the students, there was a paucity of accessible information and guidelines relating to articulation and credit transfer available from an official, centralised channel.

First, the students reported difficulties in obtaining information about the pre-transfer (e.g., articulation pathways, study patterns, and credit transfer arrangements) and post-transfer stages (e.g., graduation requirement) through formal channels such as institutional websites and instructors, where the latter were not well informed of credit/course transferability. Alternative, informal sources of this information were their peers, seniors, and social media, in spite of the limited credibility of such informal channels. As a last resort, the students said they had approached individual departments in universities to obtain guidelines and verify information about graduation requirements in relation to credit transfer. It was, nonetheless, a time-consuming process. Even with the needed information, they noted that they were overloaded and confused with the massive amount of both relevant and irrelevant information, and the transferability of some courses still remained uncertain.

Second, the transfer students who had looked for credit transfer information suggested that the transferability of credits between sub-degree and degree programmes and requirements regarding course grades should be made transparent to them during their sub-degree studies. This information could have facilitated study planning in that they could strategically take courses that were transferable to universities during sub-degree studies and hence reduce their study loads after articulating to degree studies. Since, as mentioned, this information was limited, the students relied on the alternative sources of information, which might have been outdated or even inaccurate. Particularly for credit transfer practice, unofficial information (e.g., requirements and minimum GPA) affected their decision making significantly. They reported that it was not uncommon for transfer students to mistakenly register for courses based on inaccurate information. The credibility of such information was a concern.

At a later stage of the project, when being introduced to the idea of a credit transfer and articulation information system, the students expressed welcoming attitudes and perceived this as a platform for increasing the visibility and accessibility of verified, up-to-date, and consistent information regarding articulation and credit transfer. In particular, they requested the availability of a list of courses that are transferrable between sub-degree and

degree programmes in Hong Kong, and also a searching facility for matching their potential articulation-friendly universities and degree programmes with their current sub-degree programmes. They also suggested having instructions about applying for credit transfer in various universities as well as reminders of important dates and deadlines. Compared to their existing sources of credit transfer information, this proposed system was regarded as a trustworthy repository that would save their time in obtaining and organising the information.

5.1.2. Pre-Prototyping Groundwork

The groundwork started back in August 2017. Our team took advantage of this gap and initiated the idea of a pioneering, local, cross-institutional credit transfer information system (CICIS) in the project team's first internal meeting. The ONCAT database and later the ASSIST, as well as BCCAT, were taken as a reference to develop the CICIS. After studying their features and elements applicable to our design, a project assistant prepared a hand-drawn draft layout of the system (i.e., the wireframe) in February 2018 so that discussion could be supported by the visualised ideas. Figure 1 shows part of the initial wireframe that illustrated the searching interface. In addition to continuous major input of comments and suggestions from project team members, various external parties were invited to offer their opinions on the wireframe. During this design phase, a professor from another local university and another expert from overseas acted as the main external consultants. As the prospective content (i.e., credit transfer information) providers, academic staff, transfer students from six local universities, and community colleges were also involved in refining the wireframe design. Technical advice and support were given by the departmental Senior IT Officer and the central IT Services.
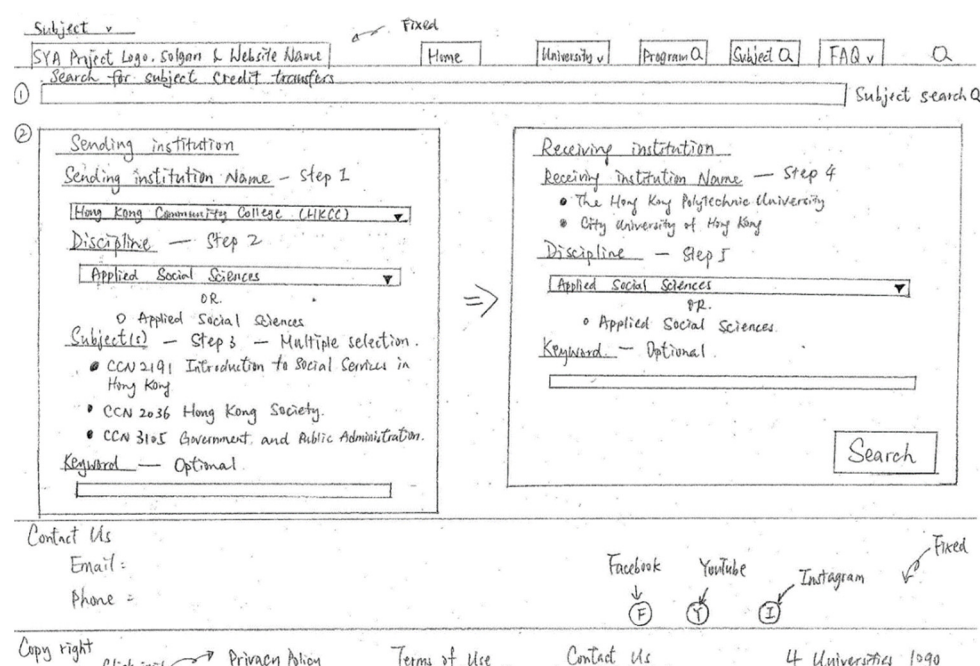


**Figure 1.** Searching interface in the initial wireframe of the system.

From September 2017 the project team started the on-going process of collecting institutional data including existing records of programme-to-programme articulation and credit transfer, from the four participating universities. Based on the users' information needs, a preliminary list of information fields was generated. The information related to the community college or sub-degree (i.e., sending) institution included *Name of Institution, Programme Title, Subject Code, Subject Title,* and *Minimum Grade Required for Credit Transfer,* while that related to the university (i.e., receiving institution) included *Year of Intake, Faculty,*

*Department, Programme Title,* and *Subject Code.* It also included *Success,* which indicated whether the credit transfer application was approved or not.

Due to the inevitable inertia in the administration policies and practices influenced by institutional cultures [64], the project team encountered considerable obstacles throughout the credit transfer data collection. At the beginning, the data collection process started from sending a request to the programme leaders of individual departments asking for articulation information and credit transfer records. However, the response rate was rather low due to the reluctance of individual programmes and/or departments to disclose such information. Furthermore, a large amount of time was spent by administrative staff in looking up and retrieving the transfer-specific information from admission records that were infrequently used by the departments. For instance, in University A, since credit transfer applications are handled at the departmental level on a case-by-case basis, the project team could only obtain a total of 337 first-hand records of subject-to-subject articulation and credit transfer from the programme leaders of the 24 bachelor's degree programmes (i.e., 41% of all programmes) and administration staff in 12 academic departments (i.e., 45% of all departments), from late October 2019 to late January 2020. This bottom-up approach to data collection was thus not entirely effective.

The project team then switched to the top-down approach for collecting data from central bodies holding the student admission data. Obstacles were encountered here too due to the concerns of privacy, institutional data sharing, and even removal of relevant data. Following numerous negotiations, some provided subject-to-subject transfer data, while some provided programme-to-programme articulation data. For instance, in University B, as of June 2020, data were obtained from only one department. University C only provided aggregated data. University D could only provide programme-to-programme articulation information since transfer students had been pre-assigned to take a certain number of unit requirements for graduation. Besides the mode of transfer (subject-to-subject, programme-to-programme, or combination), challenges were also found in using different terminologies describing identical concepts (Table 1).

**Table 1.** Examples of the different terminology used in the four universities in Hong Kong for credit transfer practices.

| Terminology | Description | University A | University B | University C | University D |
|---|---|---|---|---|---|
| Admission scheme | Direct entry to year 3 of undergraduate programmes (usually 4-year), mainly for graduates of local Associate Degree/Higher Diploma | Senior-year admitted | Advance standing II | Senior-year admitted | Senior-year admitted |
| Measurement of academic load | A measurement to quantify the amount of learning in a course or programme of study | Credit | Credit unit | Unit | Unit |
| Unit of study | A minimal unit of study | Subject | Course | Course | Course |
| Curriculum structure (category) | The general education components that all undergraduate students are required to complete as a graduation requirement stipulated by the universities to enhance breadth of knowledge and skills | General university requirement | Gateway education | General education | University core requirement |

After gathering a certain amount of data from the four participating universities, the project team focused on the intricate and time-consuming tasks of organising and cleaning the data from each university. There were either inaccuracies or inconsistencies in the collected data from the academic registries and those from departments. This was mainly attributable to the unstandardised format of data, such as inconsistent programme titles and course codes, and incomplete data submission. Furthermore, the sources of data also had to be taken into consideration. For instance, in University A, the subject-to-subject credit transfers were entered (e.g., name of institution, programme title, and course code) by the applicants (i.e., transfer students) into their credit transfer applications that eventually became the institutional records. Therefore, the collected data were cautiously managed.

### 5.2. Prototype Development

The development of the system prototype also began amid the hindered process of institutional data collection. The system was named the Cross-institutional Credit Transfer Information System (CICIS). The project team conducted a meeting in January 2018 with personnel from the central information technology support services at University A, in which the system wireframe, manpower, budgeting, contingency support, and legal matters were discussed. To stipulate the roles, responsibilities, and accountability of the four participating universities, an agreement was made in March 2018. It was also decided that the project team members at University A would be the coordinators of the system development work, and the website (i.e., online interface) for accessing the system would be hosted on its server.

Starting from July 2018, the technical development work of building the website was outsourced to a production company. To clarify the details about the wireframe, layout design, and content management, numerous face-to-face meetings, email exchanges, and phone conversations between the project team and the company were held. Before the prototype was ready, nine transfer students (i.e., target users) were involved in giving comments and suggestions about the wireframe prepared by the company in January 2019 (Figure 2). After several rounds of modifications and refinements, the company completed a functional version of the system prototype in May 2019. As detailed in Table 2, the project team proceeded to garner feedback through consultations with numerous major shareholders of higher education (e.g., government bodies and community colleges) and external reviewers. After further functional and security testing, the system prototype was fully functional in July 2019 (Figure 3) and was presented in conferences and symposia to solicit feedback continuously from external parties.

As the system only contained records of articulation and credit transfer from a single institution (i.e., University A) at that time point, the CICIS was launched as a beta version on 25 July 2019. It was promoted to various departments in the participating universities holding the articulation and credit transfer information. We aimed for their buy-in and recognition of the usefulness of this system, so that they would be more likely to share their institutional data with the project team.

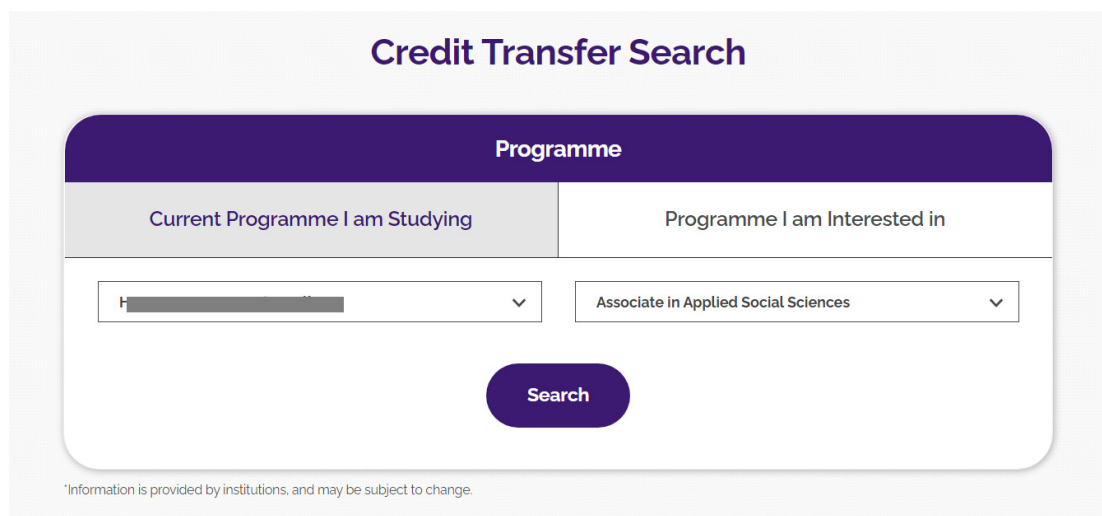### 5.3. Unforeseen Circumstances and Expert Review

From August 2019 to June 2020, while tasks for institutional data collection from three of the participating universities (e.g., negotiation) were still in progress, there was social unrest in Hong Kong that interrupted the fall semester of 2019, followed by the outbreak of the COVID-19 pandemic that continued throughout 2020. These unexpected events that caused widespread disruption to academic and general life included campus closures and transport disruption which posed inevitable challenges not only to management and administration in universities (i.e., decision makers and executors of the sharing of institutional data) but also to the project team's planning and preparation of formal user evaluations. Nevertheless, in order to provide a useful and user-friendly searching system, the project team invested time and effort in conducting seven rounds of expert

reviews, both during monthly meetings of the project team and via email exchanges within this period.



**Figure 2.** Original search interface of the wireframe prepared by the company.

**Table 2.** Summary of the key milestones of consultations.

| Time | Key Milestones | Remarks/# of Stakeholders |
|---|---|---|
| 30 January and 27 February 2019 | Incorporated target users' feedback to modify the wireframe | Nine transfer students (target users) were invited to give comments and suggestions on the draft of wireframe |
| 20–22 May 2019 | Solicited feedback from an external credit transfer expert in US | |
| 22 May 2019 | Solicited feedback from different stakeholders from the government and sub-degree institutions before, during, and after a workshop from an external credit transfer expert from US | A total of 34 participants from eight institutions/organisations joined the workshop, including both academic (e.g., Department Head, Programme Leader, Lecturer, etc.) and supporting/administrative staff (e.g., Head, Manager, Registrar, etc.) |
| 24 May 2019 | Delivered CICIS prototype presentation "Challenges in developing an online credit transfer information platform for potential senior year admitted students" | [83] |
| 21 August 2019 | Delivered CICIS development presentation "Prior learning: Recognition and visibility" | [84] |
| 2–14 February 2020 | Solicited feedback from external experts in ONCAT and ASSIST credit transfer information systems | Visited Canada and US about ONCAT and ASSIST information systems |
| 5–7 February 2020 | Delivered joint conference presentation with HKCAAVQ to share and seek feedback on CICIS from experts in NISTS | [85] |

**Figure 3.** Final search interface of the functional prototype system.

In addition to three project co-investigators, their three project assistants, and four research associates/assistants of the project team, 14 student ambassadors of the project, eight academic staff members, and five administration staff members were invited to give suggestions about the interface and search facilities of CICIS. They were considered experts due to their knowledge and experience in community college transfer, system usability, or both. Their feedback was concerned, for example, with the logo design, the content of the disclaimers, usefulness of links for navigation, and word choice.

A recurring comment was about the kinds of and the granularity of information presented in the system (e.g., credit requirements, transferrable coursework, etc.). This feedback gave rise to continuous refinements of the system prototype prepared by the company and/or the project personnel in cases of delayed responses and follow-up actions from the company. It is noteworthy that the most recent round of expert reviews was conducted in 2020 after the project team's visit to Canada and the US in a trip that aimed to gain insights from institutions outside Hong Kong.

## 6. Reflection and Future Work

This paper has reported the prototype development work of a cross-institutional credit transfer information system for vertical transfer students in Hong Kong, as an example of an Asian educational context. This system exhibits credit transfer guidelines and the past credit transfer records in order to enhance the transparency of credit transfer information to facilitate the transfer process of prospective community college transfer students. It also ensures the sustainability of credit transfer information and its application. In the longer run, it is hoped that this study will lead to an impact on the landscape of higher education, where a more efficient and effective use of institutional resources and information can benefit the ever-growing population of vertical transfer students.

Due to various challenges and obstacles encountered throughout, the system prototype was only ready for expert review but had not yet been released to the target users at the time of writing this manuscript. A formidable challenge that might have slowed down the system development process, even with some institutional data collected, was the unstandardised format of the credit transfer data. As our ongoing work, the project personnel have been formulating principles and a protocol for a more systematic process of organising and cleansing the data collected. Another major obstacle was the failed or obstructed acquisition of institutional data from the participating universities. This was a consequence of reluctance on the part of senior management and administrators from each university to expose their admission-related data; this reluctance has been described as one of the many "bureaucratic hurdles" in the scholarship of higher education [60,64,86].

Nevertheless, throughout the process of the prototype development, we met various stakeholders who provided valuable comments and suggested networks to facilitate the data collection. At present, the system prototype with limited data available from the four universities is intended to demonstrate the importance of data transparency for facilitating students' articulation and credit transfer [30,51]. This will be taken as a reference to persuade the individual departments to provide their credit transfer records in this system, and minimise the hesitation in institutional information exchange. It is hoped that the impacts of our ongoing efforts will be sustained exponentially, like tossing a stone into water, and having the ripples grow wider and wider. As our future endeavour, along with larger-scale data collection, user evaluations of the effectiveness of CICIS will be conducted to yield empirical evidence about the usefulness of the system to get buy-in from the decision-making stakeholders in local tertiary institutions.

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