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STUDENT VACANCY CODE AND THE HIGHER EDUCATION SYSTEM: DEFINITION, SPECIFICATION AND OPERATIONALIZATION OF AN INFORMATIONAL MODEL

CÓDIGO DE VAGA DISCENTE E O SISTEMA DE ENSINO SUPERIOR: DEFINIÇÃO, ESPECIFICAÇÃO E OPERACIONALIZAÇÃO DE UM MODELO INFORMACIONAL

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ABSTRACT

The control over student vacancies still remains an untheorized subject in higher education institutions (HEI). Such issue promotes a lack of mechanisms to adequately describe and manage the availability and occupancy of vacancies in undergraduate courses. This design science research characterizes that issue as a specific class of problems and focuses on the proposition, description and validation of an artifact denominated student vacancy code (SVC). The article provides the SVC's conceptual definition, its operationalization in the HEI organizational routine, the generic specification of a computational implementation of the concept, and the discussion of potential application in undergraduate decision making and management.

Keywords: Higher Education Institutions. Student Vacancy Code. Data Modeling. Computational Specification.

RESUMO

O controle sobre vagas discentes continua sendo um assunto não teorizado nas instituições de ensino superior (IES). Tal situação tem dificultado o desenvolvimento de mecanismos para descrição e gerenciamento adequados da disponibilidade e ocupação de vagas em cursos de graduação. Este artigo adota abordagem *design science research* para caracterizar esta classe específica de problemas e se concentra na proposição, descrição e validação de um artefato denominado código de vaga discente (CVDi). O artigo fornece a definição conceitual de CVDi, sua operacionalização na rotina organizacional das IES, a especificação genérica de uma implementação computacional do conceito e a discussão sobre a possível aplicação na tomada de decisão e gestão da graduação.

Palavras-chave: Instituições de Ensino Superior. Código de Vaga Discente. Modelagem de Dados. Especificação Computacional.

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1 INTRODUCTION

The purpose of this research is to propose, describe and validate an information technology (IT) artifact for student vacancy control in the higher education system, since the current state of knowledge does not allow managers to understand what longitudinally happens with a single offer and all the subsequent enrolments to fill it. The theoretical significance of this research is the development of a new concept and reflections on its adoption, both at the organisational and institutional levels. The practical importance of this research is the specification and modelling of an IT artifact (data model and state machine), and recommendations for its operationalisation in the organisational environment.

The primary sources in the student retention literature are Tinto (1987), who remarks the globally low graduation rates as a stable phenomena over time, and Gregerman et al. (1988), whose study focuses on retention efforts based on improvements of student involvement with the education institution. DeBerard et al. (2004) advance the topic by focusing on psychosocial predic-tors of retention, specially for freshmen, and currently, the research on undergraduate student retention focuses on self-regulation, motivation and achievement (Wibrowski et al, 2017); increased access and quality of education (Pitman et al, 2015); and minorities, based on race, gender, geography, income and "underresourced schools" (Gershenfeld et al, 2016, p. 3), for instance.

Despite the extensive literature that addresses this topic, to the best of our knowledge control over vacancies still remains an untheorized subject. For example, Allen et al (2011) propose decreas-ing, and possibly eliminating, student vacancy rates by means of an online application for student enrolment, but they report serious restrictions in achieving their goals, which we attribute to the ab-sence of antecedent and infrastructural concepts. Control is obviously pursued, but we understand that it is practiced in a fragmented manner and in diverse information systems over a particular organization. Moreover, this issue spreads all over the whole higher education system.

In order to discuss this, we take the Brazilian higher education system as a case to illustrate the problem at a managerial level, and also as our empirical field, assuming our experience as teachers in public universities in this country. The activities of higher education and the offer of courses for students enrollment in the Brazilian higher education institutions (HEI) follow specific regulations and require accreditation from the Ministry of Education (MEC), and possibly other relevant bodies, such as the Federal Council of the Brazilian Bar

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Association for Law courses and the National Health Council for Medicine, Dentistry and Psychology courses (Decree Number 5.773/2006). When authorized to operate, higher education courses are given a set number of places for students enrollment and the periodicity at which new places can be offered for new students. This information is delivered by means of ordinances issued by MEC (see MEC Ordinance Number 913/2015). In public institutions, this process usually happens after collegial evaluation at the levels of courses, departments, teaching centers and university councils.

Regardless of the type of entrance (entrance exam, entrance as a graduate, transfer etc.), the student, once accepted by the HEI, starts to occupy one of the places offered by the course. The selection process of new students defines the number of places offered in that specific selection process, being the ideal situation the one in which all the incoming ones remain linked to the course until reach the graduation. Thus, a course of 10 semesters with 50 seats per period is expected to have around 500 active students after the first 10 semesters of its creation. This ideal situation is altered by the dropout rate (which reduces the number of students) and the retention rate (retention considered from now on as the student's extended stay in the course after the time considered ideal for graduation, which increases the number of students). The management of these numbers (and of the dropout and retention phenomena) is one of the main challenges in the management of course coordinations and undergraduation dean offices (Costa et al, 2017).

The control of new enrollments is given by means of subtractions (number of places offered minus quantity of new students) to verify leftovers in the offer; or by additions, when a student drops out (number of places offered plus quantity of dropouts) to recompose the availability of places. Despite the longevity and effectiveness of this approach, over time and after successive en-tries and dropouts, the control of places becomes weakly linked to the original definitions (those defined in the first offers), so that, in general, at the end of a semester (usually associated with a period of enrollment) the set of students, dropouts, transfers and their various modalities of entry, dropouts and transfer do not correspond to those original definitions.

The emergence of the Enem / Sisu process in Brazil (MEC Ordinance Number 21, 2012), to which a large part of the public institutions (mainly the federal ones) adhered, has amplified this problem, since the students have more options of choice and are given more time to make that choice. It is common that the process of Sisu happens more than once

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during the year because re-maining places of courses that did not have all their number of seats fulfilled are offered for those students who did not get a place at first. This facilitates an easy migration of students from one course to another and from one institution to another. The lack of a proper control for this flow, as would be the case through a 'student vacancy code', means that the place is not treated as a strong entity in the higher education system.

So, we can postulate that the student vacancy does not exist outside the concept of the num-ber of places offered, with negative consequences on control, decision making and information management, affecting academic planning and management. For example, a course that lasts 8 se-mesters and receives 50 new students every six months, which is expected to have around 400 stu-dents after the first four years, has, after that time, a total of about 250 or 500 active students. How can these quantities be interpreted considering what was originally designed in the project of the course? Without information associated with the concept of strong entity, there is no satisfactory answer to such questioning.

We concur with a mechanism that allows better control of the availability and occupancy of vacancies in undergraduate courses, which would allow an improvement in the management pro-cesses, both at the level of undergraduate system management (or even Ministry of Education), as well as in the level of coordination of courses and management of teaching work in its linking units (departments, coordinations, etc.). In order to do so, a concept of the database theory is adopted here, which defines an entity as an abstraction of reality, required to symbolically model an object, event, phenomenon, etc., on which there is a need to obtain and store data (Teorey, 1999). A strong entity represents a set of data that has independence in relation to other data sets, since, among other factors, it has unique and proper identification (Teorey et al., 2008). It can be said that strong enti-ties have a 'life of their own' in the database, which differentiates them from weak entities (which depend on other entities) and associative entities (which depend on relationships among other enti-ties). This, therefore, seems to be the adequate concept for improving the management and control of vacancies in higher education.

This article was written in alignment with the concept of design science, as the purpose was to develop an artifact. Design science as a paradigm and design science research as a scientific method have been employed in similar contexts where (1) an organizational situation can be characterized as a class of problems of a given field, (2) an artifact can be designed to produce solution, and (3) there is evidence that this artifact addresses and has

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potential to solve the problem (Van Aken et al., 2016). This is the basic understanding used here to consolidate a set of conceptual propositions which may be applicable to the solution of the difficulties and possibilities of data management in the institutions of higher education, as described above. The focus is on the proposition, description and validation of an artifact that is denominated here as student vacancy code (SVC). To this end, the following sections are related to (a) the documentary literature on the equivalent concept of teaching vacancy code and its operationalization in the scope of selective processes (public tests) to fill vacancies; (b) conceptual operationalization and definition of student vacancy code (SVC); (c) definition of the operationalization of the SVC concept in the HEI routine; (d) the generic specification of the computational implementation of the SVC concept in the information systems of academic control; and (e) the potential uses of these codes in undergraduate planning and management.

2 CONCEPTUAL BACKGROUND

In order to have a reference of a codification like the one proposed here, the Brazilian federal public service is taken as basis. The job offer and the control of filling these vacancies happens through an 'authorization for job position provision' issued by the Ministry of Planning, Development and Management (MPDM) in collaboration with the Ministry (or Ministries) interested in the provision (see Inter-ministerial Ordinance number 399, 2016, Article 1). In the case of the federal higher education institutions (FHEI), the control of authorized amounts, the remaining vacancies and the deadlines for filling them is carried out through the 'teacher-equivalent bank' (total number of teachers that each federal institution of education can have) and respective equivalence factors (Decree 8.259, 2014, Law number 12,772, 2012).

Although 'authorization to fill a position' is the expression in the legislation and regulation on filling job positions, the expression 'vacancy code' ('código de vaga', in Portuguese) seems to be more referenced, both formally (see MEC Technical Note number 57, 2016; UFSE Ordinance number 1.457, 2017; UFSM Ordinance number 85.768, 2017), and informally (see JUS, 2017, UFSC, 2017). Notwithstanding the broad reference to the expression 'vacancy code', up to the time of writing this text there was no identification of its original mention or original formal definition. What is observed as a regularity is that the vacancy codes are composed of seven numeric digits (for example: 0917389; 0810941; see

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Ordinance number 1,181 of the Ministry of Education, 2012), although questions remain about who creates these codes and which criteria are used for the creation.

Anyway, it is an institutionally legitimized practice to associate the person in a public office with his/her vacancy code. In general, this association is foreseen since the administrative process of the FHEI, which is the first step to publicize the information about a public test to fill the job positions available. So, we suggest considering the vacancy code as a *strong entity* in the institutional database, since this coding system has demonstrated consistency in the control of admission, occupancy and change of status of professionals in the federal public service. By mapping the same concept regarding students and undergraduate courses in a HEI, the concept of 'student vacancy code' can be conceived, as we will discuss ahead.

2.1. STUDENT VACANCY CODE

The student vacancy code (SVC) consists of an unique identifier for each vacancy (a seat) in the higher education system, ontologically distinct from its temporary occupying student. The existence of such an identifier (a code, or ID identifier) allows a single vacancy to be treated as a *strong entity* in academic control systems (for example, in the federal system such as MEC, FHEI, coordinations). Each SVC is created from the course authorization and managed by an HEI, with registration at the MEC or departments.

Each HEI defines its SVC with specific coding, comprised within a code range defined by the MEC or state education departments. As a form of identification in the code itself, each HEI can use its current identifier code with the government control body as the initial component of its SVC, followed by sequential numbering. An example of SVC, following this suggestion, would be 26232.0000001, where the first five digits correspond to the institution identifier (26232 for Federal University of Bahia – UFBA, for example) and the remaining seven digits correspond to a sequentially generated number (0000001, 0000002 etc.).

Student vacancy codes have a status definition and can be in one of the following conditions: created, offered, filled, vacant or extinct. When the HEI considers it necessary to create a new SVC, a unique identifier is produced and the new SVC, with a status of 'created' is permanently associated with this identifier (once associated, there is no possibility of changing the SVC identifier). The SVC is then associated with a course and a selective

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process for entry (Sisu or transfer, for example). For the SVC to be associated with a selective process, it is required that it has the status of 'vacant'. Once associated with the selection process, the SVC will be given the status of 'offered'.

Upon entering the IES, as soon as the new students enrolls at university, they get their registration code which is obligatorily associated with a SVC. Thus, there is no possibility that a student has no SVC to occupy. Therefore, this association describes the (always temporary) occupation of the SVC by the student and the SVC receives the status of 'filled'. In case a student drops out the course, the SVC has its status changed from 'filled' to 'vacant', being thus available for new offer and occupation by another student.

A SVC has an undetermined validity period. The extinction of a SVC implies a reduction in the offer of places and can only be compensated by the creation of a new SVC. That is, even dropouts and graduation processes do not necessarily imply extinction of the SVC, since the same SVC can be associated with several selective processes and students throughout its existence, from which it is inferred that all changes in the status of the SVC are recorded and kept available for later reference.

Thus, each selective process only starts when the SVC is allocated and the allocation of a SVC to the selection process defines the number of vacancies offered. Since each SVC is associated to a course (since it is generated for the first time), the selection process also has the definition of vacancies offered by course, and in turn, each course knows its SVC, thus being able to manage them (accounting vacancies offered, vacancies filled, vacancies available, vacancies extinguished, relocation of vacancies between selective processes, reallocation of vacancies among students, etc.).

2.2. GENERIC SPECIFICATION FOR COMPUTATIONAL IMPLEMENTATION

Among all the techniques available and dealt within the area of software engineering for purposes of exposition/understanding of ideas (what will become a set of formal requirements), 'data-based specification' was adopted here, considering the more stable nature of data when compared to the evolutionary nature of the processes, even if this stability demands social behavior for its guarantee (Axelsson & Goldkuhl, 2008). In order to do so, data modeling of the proposed solution was initially used by elaborating an entity relationship diagram (Booch, Rumbaugh & Jacobson, 2006; Chen, 1976).

An entity relationship diagram (or ERD model) presents the data of an information

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system as real-world entities (objects, events, and their descriptive attributes) related to each other as a function of their dependencies and associations (Chen, 1976). An ERD model follows a specific notation and can be used to formally describe the data structure of any organizational area, both at the conceptual level (closest to organizational practices) and at the logical level (closest to computational practices).

Diagram 1 illustrates a possible ERD data modeling for SVC implementation in academic control information systems. It is observed in Diagram 1 the proposition of two new entities (Tab_SVC and Tab_Moviment_SVC) and the assumption of existence of entities similar to Tab_Courses, Tab_Students and Tab_Selective_Processes, since, by presumption, the HEI already have data referring to courses, students and selective processes in their information systems.

The second technique adopted for data-driven specification addresses specifically the domain of SVC states. The concept of 'state machine' defines an abstraction for the design of control mechanisms of software type or logic circuits. An automaton can be considered a finite automaton (FA) when the amount of possible states is established a priori, and deterministic automaton (DFA) when the state transitions are associated with specific inputs and it becomes possible, therefore, to determine what the next state of the automaton is. Non-deterministic finite automata (NFA) are used in situations where the next state of the machine can not be determined a priori and are used in situations where there is ambiguity or incompleteness in the determination (Sipser, 2007). In both cases, deterministic or non-deterministic, the FA is defined by means of a quintuple containing: (a) finite and non-empty set of possible states (for example, open or closed door); (b) alphabet of the automaton (set of actions that determine change of state, for example, door opening, door closing); (c) transition function; (d) initial state; and (e) set of final states (optional) (Sipser, 2007).

State machines are useful because they formally define the behavior of a system and because they offer multiple forms of representation (mathematical, table and diagrammatic representation). Using the state machine concepts, the control of each SVC is defined as a non-deterministic finite automaton, in which the possible states are defined a priori, but there are multiple possible state transitions. For example, a SVC can be filled (vacancy filled) or vacant (vacancy not filled) after a specific selection process (vacancy offer).

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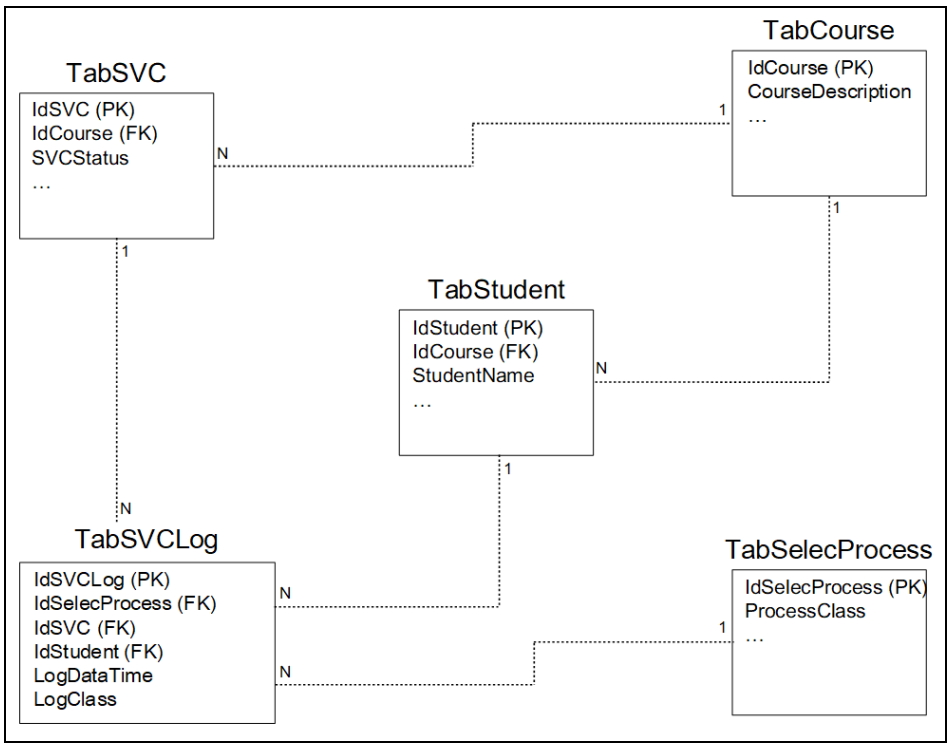
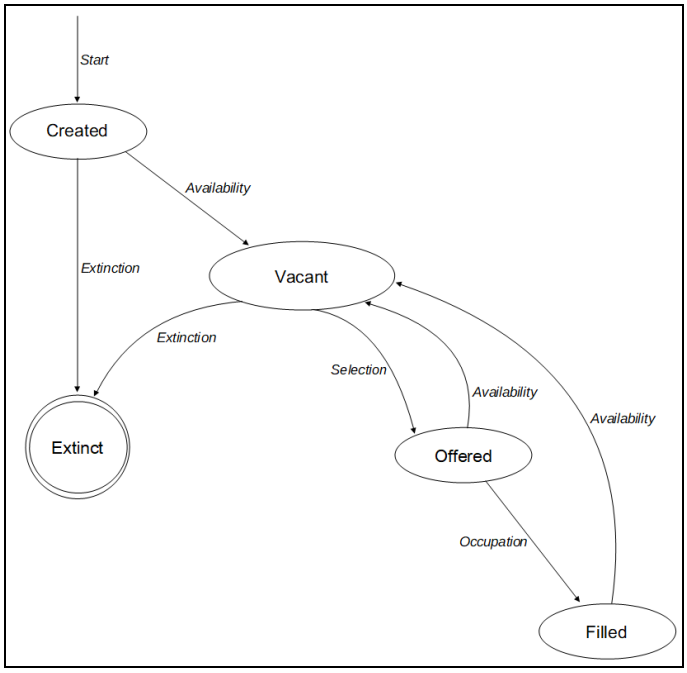
Diagram 1 SVC Data Model



Thus, the initial state of the FA is 'created'. In this state, the FA alphabet is restricted to 'creating SVC' and possible transitions are to 'vacant' states (in which the SVC waits for an association to a selective process) or 'extinct' (when a SVC is extinguished before being offered). 'Extinct' is also the only possible final FA state.

Diagram 2 Transition of SVC states



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When the SVC has the status of 'vacant', it has the alphabet 'SVC waiting to be associated with a selective process or extinction' and the possible transitions are for the status 'offered' or 'extinct'. Once it has the status of 'offered', the FA has the alphabet 'SVC waiting for association with a student' and the possible transitions are for the status 'filled' (when a student is associated with a SVC) or 'vacant' (when the SVC is not associated with a student in that selection process). When 'filled', the SVC has the alphabet 'student enrolled' and the possible transition is to 'vacant' (when the student is no longer associated with the SVC, either by dropping out or graduating). Thus, the FA can be represented by means of Diagram 2, which can be implemented in conjunction with the data model defined in Diagram 1.

3 OPERATIONALIZATION IN THE HEI ROUTINE

In order for the SVC concept to be operational in the HEI routine, it is necessary to incorporate specific tasks in the organizational processes, usually called 'academic control'. First, there must be the process of creating a SVC. Creating a SVC requires the participation of the collegiate bodies that propose, homologate, authorize and regulate the expansion of vacancies at HEI. Once regulated, and assuming that there is a MEC approval, the institution responsible for administering the courses that will receive the new vacancies (usually a Dean Office) must register the new SVC in sequential numbering (or according to specific definition of FHEI) and associate these new SVC with the respective courses. The new process also requires the new SVC to be informed to the course coordination for knowledge and further references.

Second, the organizational process of selecting new students (whatever the mode of entry) must be modified to contemplate the new stage of 'SVC registration of the selection process' This new step associates a set of SVC to the ongoing selection process, so that the number of vacancies offered in the selection process is defined taking into account (besides other aspects of the academic decision) the number of SVC associated with the process. The association between the SVC and the selective processes requires that the related SVC bare with the status of 'vacant'.

Third, the organizational enrollment process in HEI should be modified to contemplate the new stage of 'occupation of SVC'. This new step associates a SVC with a student enrollment and is required so that the 'candidate' can only be considered a 'student enrolled'

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in the HEI when (1) is approved in the selection process (regardless of the selection criteria); (2) presents the documentation that proves their statements; (3) confirm their intention to take course at the HEI; and (4) receives a SVC associated with their enrollment number.

Fourth, the organizational processes of registering the dropouts (whatever the modalities) and course conclusion should be modified to contemplate the new stage of 'vacancy of the SVC'. This new step unlinks a SVC from a student enrollment, making the SVC available for a new offer. Processes such as matriculation in subjects, enrollment in discipline or cancellation of enrollment in discipline (that is, processes that do not change the student's link with the HEI) should not involve a SVC movement.

Finally, the organizational process of reducing admission vacancies (whatever the modality), must be modified to contemplate the new stage of 'SVC extinction'. This new step requires that the SVC to be extinguished has the status of 'vacant'. The extinguishing process permanently disables a SVC for supply and occupation, while maintaining all records of the SVC movement throughout its existence.

4 USES OF THE SVC IN INSTITUTIONAL AND ACADEMIC MANAGEMENT

Some possibilities of using the SVC in the management and the support to the decision-making process need to be highlighted. This section analyzes two perspectives, the first one associated with national or state system management, assuming a possible use of this tool at the level of the Ministry of Education or the states' level government department, and the second at the level of the HEI and the course.

4.1 USES AT HIGHER EDUCATION SYSTEM LEVEL

We deduce that the implementation of a SVC has value from the point of view of control of flows and processes of the student development throughout the course. Indeed, given the student's attachment to a well-defined entity (the SVC), it is feasible to identify by the SVC status transitions the total enrollment of students in a semester or year (by analyzing the amounts of SVC that have changed from 'vacant' to 'filled'), as well as the number of graduates or dropouts from identifying the causes of a SVC shifting from 'filled' to 'empty'.

Assuming that there is interest in analyzing the comparative performance of different HEI or large training areas, the SVC registration status may also be useful, since the maintenance of a national or state registry enables the extraction of quantitative data from the

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units over time. In this way, it is possible, for example, to extract in each semester and by each HEI the percentage of codes that changed condition by dropouts and hence to define a comparative measure of relative dropouts to the total of filled codes by HEI. This would allow to compare and analyze the level of dropouts in all HEI. The same procedure can be done for complementary analysis of graduation per institution per semester, as well as to identify the student retention from the calculation of period of time that the code remained 'filled' until it became 'vacant' after student graduation. The temporal analyzes are in fact made possible, since there is a means to accurately measure the time between each change of a SVC status (from created to offered, from offered to filled, from filled to vacant, and so on).

A complementary analysis that may be relevant in higher education planning is the identification of student flows between courses or between HEI. Thus, since at any time it should be possible to consult the movement of a specific SVC, as well as a group of SVC, it is then possible to answer questions such as: *what is the number of vacancies offered by course?; and the number of vacancies available per course?; which SVC were occupied by a person in that HEI?;* or even *which or how many students took SVC number 'X' and changed to SVC number 'Z'*. Since the SVC can be referenced either by identifying a student (specific enrollment number and course) or by their social security number (in Brazil it is named CPF), it is easily identifiable what the student's transition between courses or institutions has been. This allows, for example, to analyze the 'migratory flows' of students, using in addition to the conceptual metaphor of Demography as an academic discipline, all the tools of analysis of migratory flow that this subject has.

4.2 USES AT HEI LEVEL

What has been suggested as operational and potential analyzes at the national or state level is possible to be adapted to the HEI, from the perspective of the institutional management of their units (centers, colleges, institutes ...) and their courses. Thus, the analysis of SVC status changes in each semester allows for easy verification of levels of dropouts, graduation and retention by course or institution. Likewise, it is possible to establish comparative references between units and courses to analyze student flows (between institutions and courses), something that occurs recurrently. This would allow, for example, to analyze the level of dropouts in courses that do not generate dropouts in the HEI, which are the cases in which the student vacates a SVC in one course of the institution, but instead

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occupy another SVC of another course of the same institution.

There are also other current actions of academic management that can be improved from the analysis of status and changes of status of the SVC. For example, it is possible to evaluate the 'turnover' of codes, in order to analyze how many of these codes are filled and vacated by course and hence derive decisions regarding the selection of students, either to increase or reduce the regular supply of vacancies (in selective processes semiannual or yearly) as well as for the adoption of strategies to fill SVC that will be vacated by dropouts, regulating processes such as 'enrollment of graduates', 'enrollment of graduate students' (students who already finished a university course, but want to study in another field) etc.

The analysis of the level of occupation of the SVC by course can also contribute to validating the processes of closing courses, considering the occupation of the SVC by regular offer as a proxy of the attractiveness of the course. Let us take the case of the Federal University of Cariri (UFCA, 2017) which, in February 2016, began the process of closing one of its courses, which had started its offer of places in 2014 (the course was definitely closed in 2017). According to UFCA reports, with the offer of three semesters (taking the reference of 40 vacancies, 120 vacancies were then offered), they managed to keep less than 40 students enrolled. Assuming that this decision was based on the SVC occupation, the argument would be more consistent to show how much of the total of offered codes were offered and filled or not, and if they moved from filled to vacant state because of a dropout, to then have an objective metric and be easy to verify for the decision making (as the decision of closing the course; it should be noted that the closing or opening of a course is not only defined by its attractiveness, but social and economic aspects among others are considered; data on registry manipulation of the SVC are always oriented to generate information to improve decision making).

5 VALIDATION

We assumed as criterion for validation of the proposed artifact a mix of analytical and descriptive evaluations, as stated by Dresch et al. (2015). The validation of the solution occurred through two exploratory focus group. The first was done exclusively with IT professionals (information systems manager, two analysts and one IT technician, with an average experience of 11 years in the field), and the objective was to validate the proposal and its feasibility of implementation taking into account technical and technological requirements.

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There was no criticism of the data specification or the proposed state machine, and the focus of the discussion was the determination of the initial quantification of SVC for each course taking into account that the implementation of the code could be done in existing courses. As a result of this first question, the authors opted for the implementation of a report that presented, for each course, the number of vacancies offered per admission (per period), the number of regular curricular periods (estimated duration of the course) and the number of active students in the course. With these data it was possible to verify the cases of 'gap' (fewer students than expected, possibly due to a higher level of dropout or not filling vacancies) and 'tightness' (more students than 'expected' vacancies, which is possibly due to high retention and/or compulsory transfers). The central conclusion was that the SVC has full implementation conditions from a technical and technological point of view, and it was also evidenced that the creation of SVC for existing courses should be done considering an adaptation period, with prediction of a flow of code extinction at least until the cases of large gaps or tightness are stabilized.

The second focus group was conducted with academic managers (undergraduate Dean and three lecturers with experience in course coordination) and an IT analyst (with 13 years of experience). The objective was to validate the operationalization of the concept in the academic routine. Again, there was no criticism of the data specification or the state machine. The central point of the discussion was the understanding of cases in which vacant places (non-filled or dropouts) return to the available-for-offer condition, in particular because of the (operational and academic) definition of SVC occupancy considering the curricular completion characteristics of the students of the course (that is, of the filled SVC). For example, it is possible that a given course has a percentage of vacant codes, but that the disciplines in the first periods of the course are all with the highest possible number of students. This indicates, therefore, that the occupation of vacant SVC must be done by the requirement that the occupants have already passed through these initial phases of the course (for example, for a Mechanical Engineering course with excess students up to the second year and few students in the last two years, vacant SVC must have as occupancy requirement that the potential occupant has already met requirements for the first two years). This observation has no implication for the proposal but emphasizes the impact of code adoption on occupancy decisions (particularly on course transfers or graduates' admission) and on the potential reports and indicators to be extracted in relation to the filled codes of the courses to support

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the decision-making agents (coordination and Dean office staff) in the management of the codes.

6 FINAL CONSIDERATIONS

This research is innovative because offers a definition, specification and operationalization for the concept of student vacancy code (SVC), applicable both at the organisational and institutional levels. We define a SVC as an unique identifier for each vacancy (a seat) in the higher education system, ontologically distinct from its temporary occupying student; we also offer a specification for computacional implementation in academic information systems (a data model and a state machine); and we discuss diverse levels of the concept operationalisation in the managerial routine.

As a proposal, the SVC rationale is grounded on a previously validated concept (the teaching vacancy code of the federal higher education system); on the database literature, in particular the 'strong entity' concept; and on the authors' experience in analysis of graduation, dropout and retention data. We established SVC initially as a proposition and recommend, therefore, that this proposition should be improved with implementation of the concepts in an HEI, for validation purposes. The implementation and testing of functionalities and possible uses will define additional and emergent considerations, unpredictable at this moment.

Three managerial challenges arise and can be anticipated from the implementation of this proposal: (a) at the institutional level, (b) at the organizational level and (c) at the operational level. At the institutional level, it is necessary that the SVC is formalized in institutional regulations, both at the system level (national or state) and in the organization, following the flow and normal requirements for this type of institutionalization (formalization of norms, collegial approval, regulations and uses, adjustment with other pre-existing regulations, etc.). At the organizational level, it is necessary to join the decision-making and institutional management levels, both to require the implementation and the subsequent use of the benefits generated by the SVC, with the implementation of the flows, processes and rules of use, as well as the definition of responsible sectors, user sectors with manipulative permissions (for example, creation or extinction of codes). And, finally, at the operational level, technical and technological adjustments are required in the systems (national or state) and in the HEI with definitions, adjustments and alignments with other techniques and rules on student data. The experience of managing these issues and overcoming these challenges

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can be the basis for future studies that will report successful experiences, requirements and methodological innovations, including in articulation with other recurring themes in university management studies, such as organizational innovation, process and resistance to change, technological alignment, data-based management, among others.

The suggested analyzes (of flows, dropouts, graduation and retention or support to decisions to fill vacancies) are relevant for academic management at institutional and course level and would already be indications of the potential value of SVC implementation, notwithstanding other possibilities that may arise and can be tested in addition. Linking theories and developing further studies on acceptance, use, knowledge management, competitive advantage, dynamic capacity building and other issues related to SVC employment may be the basis for academic research on the influences of the new concept on the HEI organizational environment.

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