

The planning and development of an integrated research information system in a university

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Introduction

The planning and development of new information systems, including the redevelopment of existing information systems in the National University of Singapore is based on a data management approach ie the University-wide data model serves as the foundation for all administrative information systems development work. When the University's data model was first prepared in March 1990, three main subject areas were clearly identified, namely Student, Staff and Alumni. It was at this stage that the possibility of a fourth subject area Research was first explored.

Up until now, most of the University's data on research has not been computerised with the exception of two information systems setup by the Bursar's Office in the 1980s. One of these systems records the expenditures of outside funded research projects whilst the other system monitors the progress of University funded research projects. There is also a textual database setup by the University Liaison Office for the on-line retrieval of information pertaining to the current research interests of staff members.

In the last few years, there has been a rapidly expanding research culture in the University in line with the Singapore nation's vision of having the University play an active role in advancing the frontiers of R&D (Research and Development) in Singapore. This has led to the commissioning of new research institutes within the University as well as the formation of industrial collaboration centres within the various Faculties to help promote and intensify the University's R&D ties with industry. To propagate the spread of research culture, much of these activities have been decentralised to the Faculties and research institutes.

More recently, it has been recognised that there is a need for the University to develop some indicators to monitor and measure the research output of the University. Some of the indicators presently used by the University include the number of research publications of staff members and number of funded research projects.

Two sources of data have been used to compile statistics on research publications of staff members, namely the publications lists provided by staff members in their curriculum vitae submissions to Personnel Department for the annual staff review and the staff members' submissions to the University Liaison Office for the University's annual publication on Publications and Theses. Since both sources of data are textual, much time and effort is required to code, data capture and edit the data before it can be used to provide meaningful statistics. Furthermore, the presence of the two sources of data on publications of staff members means that the number of research publications reported by the two sources will not be incomparable.

Considerable effort is presently also required in compiling statistics on number of funded research projects. Since the two information systems implemented in the Bursar's Office are designed primarily for accounting purposes, it can only provide aggregate data on the funds spent on the various funded research projects. For more detailed analysis, additional data will need to be collected, coded and data

captured. The additional data will also include information on the unfunded research projects carried out by the Faculties which are not required by the Bursar's Office systems.

Arising from this need to design an integrated information system to monitor the research output of the various research activities in the University, the Integrated Research Information system was conceived.

Objectives

It was recognised from the start that the Integrated Research Information system will be a University-wide system, designed to meet the needs of the Bursar's Office, Personnel Department, University Liaison Office, Library and the Faculties. The Planning Services Unit which has been assisting the University to compile indicators on research output was made responsible for the coordination of the entire planning and development work. The computerisation aspects of the system are being handled by the Computer Centre.

The initial objectives of the project were defined based on the requirements of the University Liaison Office and the Library, and then integrated with the requirements from Bursar's Office and Personnel Department. At about this time, the University was also aware that the Centre for Industrial Collaboration of the Faculty of Science was interested in developing a database on the research profile of the staff members in their Faculty to facilitate industry's access to information on expertise in the various fields. Following from discussions with the Faculty of Science, it was agreed that the Faculty's requirements could be incorporated in the system. It was further agreed that the Faculty would be the pilot site for the Integrated Research Information system. It was also coincidental that the Dean of Faculty of Science had earlier been appointed the Adviser for the project to advise on the academic departments' needs for the system.

Hence, the final list of objectives for the project included the following:

- to promote and facilitate multidisciplinary research as well as industrial collaboration within and without the University
- to enable the University to identify staff members with particular research interests and thus facilitate matching them with research opportunities
- to enable the University library to identify and disseminate appropriate materials to support faculty research.

Data model of system

The data model for the Integrated Research Information system was prepared based on the objectives of the project. This data model provided a schematic representation of the various entities in the system and showed the relationship between the various entities. A schematic diagram of the data model is given in Figure 1 (at end of paper).

(Note: Glossary of terms used in Data Modelling

Entity refers to a thing eg Staff, Student, Research Publication, etc.

Relationship refers to a logical linkage between two things. This linkage is formulated based on the University's business rules eg a staff member may author many research publications ie the staff member may be the main author or co-author of one or more research publications.)

There is an accompanying data dictionary which describes the various entities in the data model. The data dictionary for the Integrated Research Information system was compiled based on inputs from the various departments collaborating on this project. Details of the data dictionary for the Integrated Research Information system is found in Annex 1.

The data model and data dictionary provide a basis for a common understanding among the various collaborating departments on how the various entities in the Integrated Research Information system are linked to each other. In particular, it helps the University to establish the linkages between the “data owners” and the “data users”. When this link is established, the “data owners” and “data users” gain a better insight into how their data needs are integrated, and this leads to closer collaboration and cooperation efforts among the departments concerned to ensure that data collected by “data owners” are gainfully used by the “data users”.

Overview of various application systems

The Integrated Research Information system comprises the computerisation of the following application systems:

Application System	Collaborating Departments
Research Publications	Personnel Department University Liaison Office Library Faculties
Research Projects	Bursar’s Office Faculties
Staff Consultancy Work	Personnel Department Bursar’s Office Faculties
Current Research Interests	Library University Liaison Office Personnel Department Faculties

A brief description of the scope of each of these application systems and how these application systems benefit the various collaborating departments is discussed below. A description of the procedures that are being developed or planned will also be discussed, wherever possible. It should however be noted that since these application systems are in various stages of planning and development (the entire Integrated Research Information system project is envisaged to be implemented in phases within the next two years), the procedures at best describe the project’s present plans and developments. These procedures are subject to possible changes as the application systems are being developed.

Research publications

System objectives

The system will maintain a database of the research publications of the University’s staff members. The publications data from this database will be used by the Personnel Department for its annual staff review purposes, as well as used by the University Liaison Office for the compilation of its annual publication on Publications and Theses. Information on staff members’ publications history will be made available to the Faculties and Library for on-line enquiry and reporting purposes as well as for publication of Faculties’ publications on research publications of staff members.

It should be noted that the Research Publications system will provide a single source of data on staff members’ publications, thereby leading to a consistent source of information University-wide. This source of data will also be comprehensive since it is based on information submitted by staff members to Personnel Department in their curriculum vitae for the annual staff review. Up until now, one of the common difficulties encountered by the University Liaison Office in the compilation of the University’s annual publication on Publications and Theses is incomplete information since the University’s publication on Publications and Theses offers no direct benefit for staff members to provide a complete and up-to-date staff publication list (unlike the publication list provided in the curriculum vitae for the annual staff review purposes). Furthermore, publication lists of staff members who have left or are about

to leave the University's employment are frequently not available, thereby leading to a possible understatement of the University's research output in this University publication.

Before the development of this system, the only information available to Faculties on staff publications consisted of hardcopy information compiled yearly for the annual staff review (there are two review sessions per year for different categories of staff members, in May and October respectively), Publications and Theses (compiled as at December of each year) and Faculty publications (which are compiled by some Faculties only). With the implementation of the Research Publications system, Faculties will be able not only to enquire current data on staff publications on-line, but also monitor the research output of their Faculties on a current basis.

The Library presently maintains a hardcopy of all publication papers of staff members. Like the University Liaison Office, this department also encounters difficulty in obtaining an up-to-date list of staff publications. The Library has requested for the inclusion of a data item to indicate whether the publication is available in the Library in the Research Publications system. This data item will be maintained by the Library and used by the Library to follow-up currently with Faculties on all outstanding publication papers not yet sent to the Library.

Procedures developed to date

A one-time coding, data capture and editing of the publications details of staff members prior to 1990 was carried out by Planning Services Unit based on the textural information in the publication lists which staff members submitted to Personnel Department in their curriculum vitae for the annual staff review. A listing of the computerised publications data has been sent to the staff members for their verification purposes. A sample output of the verification listing (which also lists the data items captured in the system) is enclosed as Annex 2. [Note: The original material for this Annex was rather faint photocopies, and it has not been possible to reproduce them in this web edition.]

During the verification stage, staff members were also required to provide the following additional data items:

i.	Keywords	Six keywords most appropriate for describing the publication work. It is envisaged that these keywords may facilitate retrieval of publication work by current research interest in future. (Note: This item is applicable to all publications except book reviews and editorial work on journals.)
ii.	Details on Research Project	Items (a) and (b) are applicable to publications which are the output of a Research Project.
a.	Account number of project	This item is applicable to funded research projects only. It refers to the account number assigned to the research project.
b.	Name of research project	This item refers to the name of the research project.

It should be noted that data collected on research projects will facilitate the linkage between research projects and research publications data. Further details of this linkage are discussed under the system objectives for the Research Projects system.

A one-time classification and setup of a master file of the journal titles of all existing journal publications (of staff members) was carried out as part of the coding and editing work. These journal titles have been classified in consultation with Faculties, and this classification is presently used by Personnel Department for its annual staff review purposes.

The Research Publications system has been designed in close consultation with the Library as they have the expertise to advise on the data items required for citing publications. In this connection, the University has adopted the citation style recommended in the Chicago Manual of Style, 13th Edition. Furthermore, the codes used for coding the journal titles of journal publications in the system are based on the call

numbers assigned to the serials collections catalogued by the Library. This approach will facilitate future retrieval of journal publications from the Library's serials collections.

When the Research Publications system is implemented, it is intended that the updating of staff publications will be carried out on-line by staff members since the application system will be implemented as a University-wide office automation application on the University's Campus Network. The system is designed such that publications data will be entered by the first-named University author. Where the first-named University author is away (eg on sabbatical leave), procedures will be available for the other authors to enter the publication data (and an electronic notification will be automatically sent to the first-named University author). Data integrity checks (eg Call No/Vol No/Issue/Page No(s) checks, ISBN checks, etc.) will also be built into the system to minimise data capture of duplicate research publications.

Research projects

System objectives

The system will maintain a database of all research projects (funded and unfunded projects) to facilitate the monitoring of all new and ongoing projects. Besides the funding and expenditure information required by the Bursar's Office, this system will also capture information on the industrial collaboration aspects of the project as well as research projects carried out using existing departmental resources with no additional funding support. The Faculties will be able to use the information in this database to monitor the progress of the Faculties' industrial collaboration efforts (eg number of projects under University-Industry collaboration, etc.) as well as the status of the Faculties' multidisciplinary projects.

Presently, only data on funded research projects is available from the Bursar's Office information systems which were designed primarily to meet the Bursar's Office needs.

In recent years, the University has been actively monitoring the status of Faculties' multidisciplinary projects. Since the information captured in the Bursar's Office information systems is primarily used for accounting and financial reporting purposes, Faculties need to compile separate hardcopy reports on the status of the Faculties' multidisciplinary projects (Multidisciplinary projects refer to research projects which involve collaborations between staff members from different Faculties. These projects may include research projects carried out using existing departmental resources with no additional funding support).

With the implementation of the Research Projects system, a complete database of both funded and unfunded research projects will be available for enquiry and reporting purposes. This will be particularly helpful to Faculties since they need a complete profile of all research activities, including the work carried out on unfunded research projects. The funded research projects can continue to be maintained by the Bursar's Office, whilst the unfunded research projects can be maintained by the Faculties. The additional information pertaining to the industrial collaboration aspects of the research projects will also need to be maintained by the Faculties. With the implementation of the Research Projects system, the current status of multidisciplinary projects can be retrieved from the database based on information of the Faculties which the collaborating staff members (of the research project) belong to. Current information on the number of collaboration projects between staff members from different Faculties can also be readily made available for monitoring purposes.

Procedures planned to date

It is envisaged that this application system will require the one-time classification and setup of a master file of all University-Industry Collaborations (presently, these collaboration agreements are maintained manually by the respective Faculties) and the setup of a Donor master file. The Donor master file will also meet the needs of the University's Alumni Affairs and Development Office and University Liaison Office.

As is the case with the Research Publications system, it is envisaged that the initial database on research projects will be setup based on existing data on funded research projects captured by the Bursar's Office. Reformatting, coding and editing work will need to be carried out on the data before it can be made

available to Faculties for verification and data capture of the industrial-collaboration aspects of the data. In particular, information on staff members, donors, etc., will need to be coded as these information are presently captured as textual data in the existing Bursar's Office information system which records expenditures of outside funded research projects.

Current research interests

System objectives

The proposed system will maintain a profile of the current research interests of each staff member. This profile will be used by the University Liaison Office to compile its annual publication on Directory of Current Research as well as generate the current research interest lists provided by staff members in their curriculum vitae submissions to Personnel Department for the annual staff review. It will also be used by the Library to implement the selective dissemination of specific information to individual staff members. It is envisaged that Faculties will find this profile useful as it will enable them to identify staff members with particular research interests and thus facilitate matching them with research opportunities.

As is the case with the publications data, one of the difficulties encountered by the University Liaison Office in the compilation of the University's annual publication on Directory of Current Research is incomplete information since the University publication offers no direct benefit for staff members to provide a complete research profile, thereby leading to a possible understatement of the University's research profile. However, with the integration of the Library's requirements for the selective dissemination of specific information and Personnel Department's requirements for the curriculum vitae submissions, the staff member will have a vested interest in providing a more complete current research interest profile.

Procedures planned to date

The Library has suggested that the following two items be used to describe the current research interests of a staff member:

- (a) an identifier item containing free-text words or phrases supplied by staff member, and
- (b) a subject item containing headings from the Library of Congress (LC) subject headings.

It is envisaged that the current research interest information on LC subject headings can be matched with data on new Library acquisitions (LC subject headings are presently available for all catalogued books in the Library) available from the Library's Library Integrated Catalogue application system so that the selective dissemination of specific information to individual staff members can then be implemented.

Staff consultancy work

System objectives

This system presently maintains a database of the consultancy work of staff members. Data has been captured in the system since July 1990. The system was initially developed to meet the needs of the Personnel Department and Bursar's Office. It is used by the Personnel Department to monitor the number and type of outside consultancy work carried out staff members. The system is also used by the Bursar's Office to monitor the income earned by staff members from outside consultancy work as it is the University's policy that the income earned by a staff member from his outside consultancy work should not exceed a certain proportion of his gross annual salary.

Procedures planned to date

Up until now, the Faculties' requirements for this system have not yet been considered. However, when the consultancy work of staff members is made available to Faculties, it may be possible to establish the link between current research interests and consultancy work so that Faculties can use this information to

identify staff members with particular research interests and thus facilitate matching them with opportunities for consultation work. At the present time, it is envisaged that individual information on staff member's consultancy work will only be made available to Deans and Heads of academic departments in the Faculties as this information is personal to staff members.

It is envisaged that there may also be the need to establish a link between the client and donor since the staff member's client for a consultation work may be a donor or grantor for a particular grant research project of the University.

Implementation plan

The entire Integrated Research Information system will be implemented in phases over the next 2 years. A schedule of its implementation plan is outlined in Figure 2. As discussed earlier, the Faculty of Science will be the pilot site for each application system before it is made available University-wide.

Conclusion

This paper has discussed the framework used for the planning and development of an Integrated Research Information system in the National University of Singapore. Since the data model is used as the basis for the planning and development work, it is possible to identify and establish the linkages between the various entities in the data model before the development of the application systems. This approach is envisaged to improve the timeliness and quality of the data in the application systems being implemented and thus support the overall institutional planning work on research output in the University.

Annex 1: Data Dictionary for the Integrated Research Information System, National University of Singapore

Client refers to an organisation for whom a staff member carries out consultation work approved by the University under the consultation/outside work scheme. The agreement between the staff member and the client regarding the work to be carried out can be verbal or in writing. It is possible that the client is a donor of the University.

Consultancy Work refers to the work that is undertaken by a staff member for an outside organization for which the staff member is paid by that organisation. Approval to undertake the work would have been granted by the University under the consultation/outside work scheme.. The type of work may include providing specialist service, conducting in-house training, etc. The staff member undertakes the work in his personal capacity.

Current Research Interest refers to the subject interest of the academic staff member. These subject interests make up the University's Faculty research profiles. This information can be used by the Library for the selective dissemination of information. An academic staff member may have many subject interests and a particular subject interest may be shared by many staff members. The subject interests also provide an opportunity to spot any multidisciplinary research topics and discover research activities in different departments that relate to similar topics, ie multidisciplinary research in the University.

Donor refers to an organization or an individual who makes an outright donation (which may take the form of money, or other resources eg equipment, staff member, etc.) to the University, without receiving any form of benefit in return.

Invention refers to a discovery made by staff members or students of the University. The University's Intellectual Property Committee reviews any patentable inventions or copyrightable works which a staff member or student wishes to commercialize. Should the Intellectual Property Committee decide that a patent application be made in respect of an invention, the invention will belong to the University. Proceeds from the commercialisation of any invention are shared between the University and the inventor.

University-Industry Collaboration refers to a collaboration between the University and any outside organisation including Government departments, Statutory Boards and the private sector in one or more of the following ways:

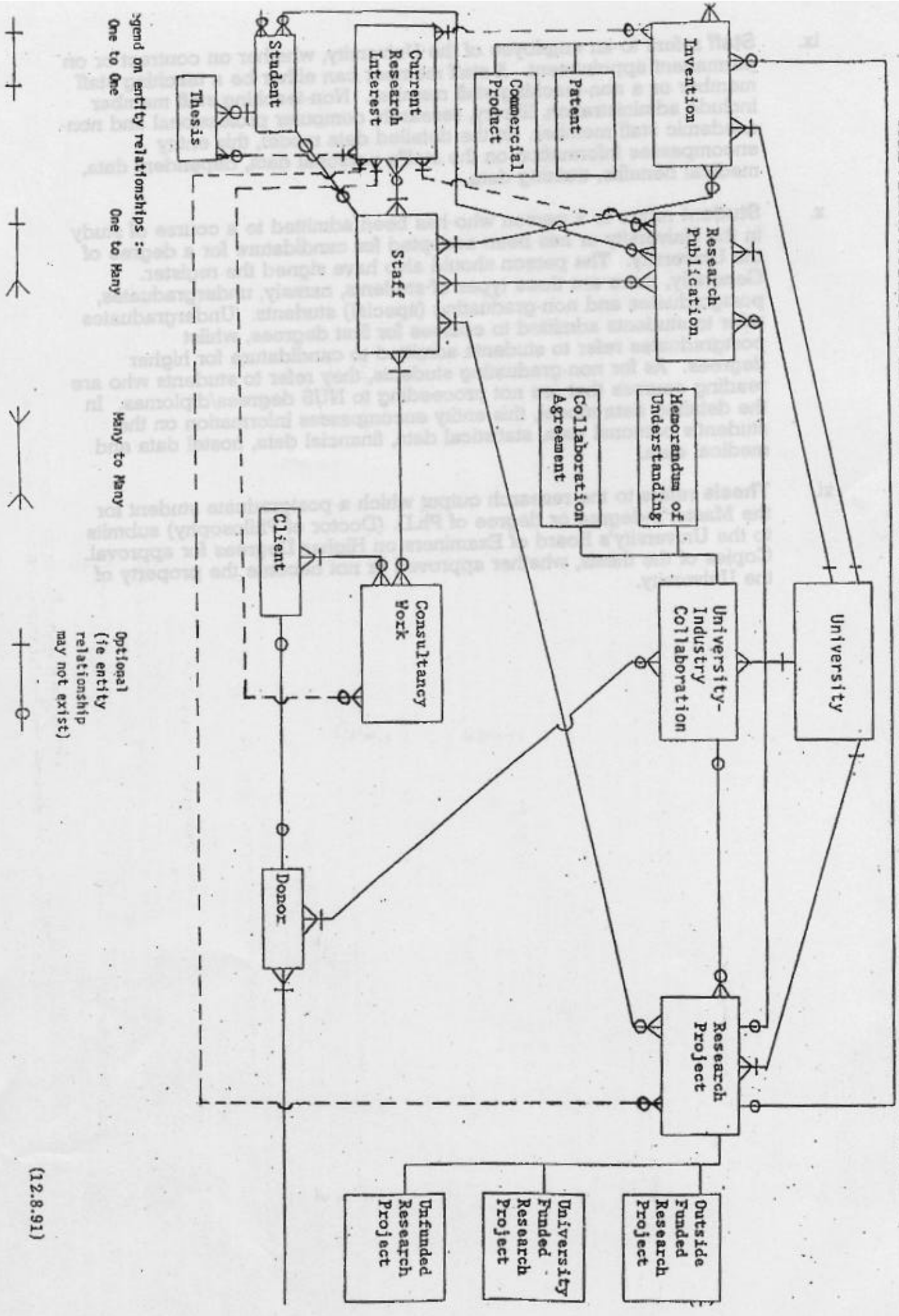
- both parties will agree in the area in which they wish to have collaboration;
- the other party may assign one or more of their staff members as investigators or supervisors of the project; and
- funding for the project may be provided by only one party or jointly by both parties.

Staff refers to an employee of the University, whether on contract or on permanent appointment. A staff member can either be a teaching staff member or a non-teaching staff member. Non-teaching staff member include administration, library, research, computer professional and non-academic staff member. In the detailed data model, this entity encompasses information on the staff's personal data, dependent data, medical benefits, training data.

Student refers to a person who has been admitted to a course of study in the University or has been accepted for candidature for a degree of the University. The person should also have signed the register. Generally, there are three types of students, namely, undergraduates, postgraduates and non-graduating (special) students. Undergraduates refer to students admitted to courses for first degrees, whilst postgraduates refer to students admitted to candidature for higher degrees. As for non-graduating students, they refer to students who are reading courses that are not proceeding to NUS degrees/diplomas. In the detailed data model, this entity encompasses information on the student's personal data, statistical data, financial data, hostel data and medical data.

Thesis refers to the research output which a postgraduate student for the Master's degree or degree of Ph.D. (Doctor of Philosophy) submits to the University's Board of Examiners on Higher Degrees for approval. Copies of the thesis, whether approved or not become the property of the University.

FIG.1 : DATA MODEL FOR THE INTEGRATED RESEARCH INFORMATION SYSTEM, NATIONAL UNIVERSITY OF SINGAPORE



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