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Development and assessment of a decentralized management system for doctoral student administration

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ABSTRACT

The main aim of this project was to establish a decentralized management and administration system for doctorates at the research unit of the Department of General, Visceral, and Transplant Surgery at the Medical Faculty of Ludwig-Maximilians-University Munich. A flow process chart conforming to the quality management system and detailing the sequence of a standardized initial introduction has been established. In order to determine if the introduction in each core facility was successful, a multiple-choice evaluation was implemented. Secondly, a welcome package has been created, which contains important information on how to start work in the department and also describes the necessary introductions and briefings and their sequence. Between 2018 and 2020, 20 applicants were accepted as doctoral students in the Department, two of them already finished their experimental work. Median duration of the introductory procedure was 20 days with minimum of six (6) and maximum of 121 days. Analysis of the test results revealed that in four types of briefings, all students passed the tests on the first attempt. However, for four other types of introductions, 5-31% of the students had to repeat the introductions due to failing the aptitude tests. All students were subsequently able to pass the aptitude tests at least on their second attempt. We successfully developed a decentralized management and administration system for doctorate students. Based on internal evaluations using key-indicators as well as the SWOT analysis, we can conclude that this management system could be used by research facilities that educate doctorate students.

Keywords: Company medical dissertation; management of doctorate students; post-graduate education; SWOT analysis.

INTRODUCTION

In 2003 Weihrauch and colleagues asserted that medical dissertations should not be phased out as they are still highly valuable educational processes for medical students to attain a scientific qualification (Weihrauch, 2003). This argument was in response to the proposal of the

German Council of Science to radically change the present format of medical dissertations (Wissenschaftsrat, 2002). Subsequently, this sparked a profound discussion about how to assure the quality of education and medical dissertations that lead to an academic MD title (Dr. med.). It should be stressed, that about one third of MD students polled reported that they received poor or nonexistent training to prepare themselves for scientific research, and 76% of respondents wished in general a better situation with their doctorate (Dewey, 2002). In this context, the German Council of Science proposed the following recommendations for the creation of special administrative structures for the management of doctoral education in medicine in order to secure certain standards: (i) a clear transparent structure with defined responsibilities, (ii) transparent procedures of quality assurance as well as of the applicant selection, (iii) a reasonable length of the doctorate (Wissenschaftsrat, 2004). Later they were elaborated on to provide clear requirements for quality assurance (Wissenschaftsrat, 2011).

These were implemented from 2010 onwards in many universities in Germany, including medical faculties to provide structured doctoral programs, which emulated the training offered by research groups of the German Research Foundation. The Munich Medical Research School (MMRS) is one of such successful projects and their program has been recently extended to the Faculty of Medicine of the Ludwig-Maximilians-University (LMU) (Munich Medical Research School, 2021). MMRS is the core administrative unit at the Faculty where all matters concerning doctoral studies have to be managed. However, such an administrative institution cannot provide day to day operative management and administrative support for doctoral students in each scientific department of the Faculty.

Therefore, the aim of this project was to establish a decentralized management and administration system for doctorates according to a quality management system (DIN EN ISO 9001-2015) at the Department of General, Visceral and Transplant Surgery, one of the structural units of the Medical Faculty (Pfitzinger, 2015). This system should provide a structured, standardized and in-depth initial training for new doctorate students including project-specific legal requirements.

METHOD

The long term goal of the scientific division (Experimental Surgery) of the Department of General, Visceral and Transplant Surgery is to educate new generations of translational research scientists to be able to assume leading positions in the academia. The selected postgraduate students will be exposed to innovative and unique approaches in order to facilitate training to carry out research independently with the ability to critically evaluate their research and achieve a broad-understanding in the course of their doctoral studies. Therefore, the intended learning outcomes were defined as follows: (i) scientific competence: e.g. ability to develop a scientific hypothesis and design an experimental test strategy whilst keeping in mind the ethical dimension of science; (ii) regulatory competence: e.g. knowledge of legal requirements (such as genetic engineering, safety at work) and basics of quality management; (iii) technical and analytical competence: independently carry out experiments and interpret experimental data; (iv) presentation skills: doctoral candidates must be able to give scientific talks, present scientific posters and write scientific articles. To achieve these goals, a good functional administrative structure for doctoral students is a prerequisite. This management system should be implemented according to the SMART principles (Doran, 1981) and therefore must (i) be *specific*, meaning that it provides a basis for development of technical competence in doctoral students (see above); (ii) be *measurable*, meaning that the basis for development of the technical

competence can be assessed and evaluated; (iii) be *attractive* and *realizable*, meaning that it does not require additional personnel, time or investment costs and (iv) have a reasonable *time frame*. Finally, this concept should be supported by premises of the modern andragogy and create a basis for the lifelong learning (Bazhin, 2020).

This paper presents the management concept developed by the authors with participation from technical and administrative colleagues (see acknowledgement) in the Department in 2017. This concept was applied continuously as a standard operating procedure (SOP) for new doctoral students since 2018. The first key-indicator, which is the duration of the process from start of official registration as a student in the Department until the start of the practical experiments has been chosen as it is a relevant factor for the students as well as quantifiable and reliable. The second key-indicator was the pass rate of the knowledge tests set to indicate a successful introduction (see below).

All quantitative and qualitative statistical analyses were performed using GraphPad Prism Version 7.01. Distributions of continuous variables were described by median, 25% and 75% percentiles, minimum and maximum, analysed with the Mann-Whitney test and presented as a scatter plot. Qualitative variables were plotted as stacked bars and analysed with the χ-square test.

RESULT AND DISCUSSION

Development of a flow process chart of the management system

The administrative process for doctoral students is depicted on Figure 1. As soon as an application from a potential doctoral student was received, a potential supervisor from the Department assessed the suitability of the candidate (based on curriculum vitae, references and interview). The authors AVB and JW then assessed the capacity of the department as well as the suitability of the candidate before making the final decision to reject or accept the applicant. In case of the acceptance, the information about the candidate as well as all application documents were forwarded to the administrative office. The administrative staff is responsible for storing all documents, including the documentation of the applicant in the student list, preparing the agreement for the Thesis Advisory Committee (TAC) and sending the completed agreement to the MMRS office for her or his official registration as a doctoral student at the LMU.

The daily communication in the lab should be flawless to avoid misunderstandings and preventable mistakes. Therefore, international doctoral candidates have to provide the office with proof of sufficient language ability, such as a certificate proving proficiency at the B2/C1 level in English. The official supervisor will then supply the office with the TAC-agreement and the internal supervision agreement between her or him and the doctoral candidate. In parallel, the official supervisor will send the project description, including details on genetic engineering and biosafety to the Representative for Biological Safety (RBS) for registration of the project with the authorities. Then, the RBS will send information about the new team member to the persons responsible for individual rooms in the core facilities, who will give the doctoral student a general introduction in a number of supporting processes required for routine laboratory work, such as waste-management, safety at work and laboratory maintenance. To ascertain if the students have understood and assimilated the training in each core facility, a multiple-choice evaluation has been developed. An example of such a multiple-choice evaluation - the questionnaire for aptitude assessment in a cell culture room, is presented in Table 1. In order to

pass, the doctoral student should respond correctly to 70% of questions. If he or she fails, an additional training is to be carried out with a new evaluation test done afterwards.

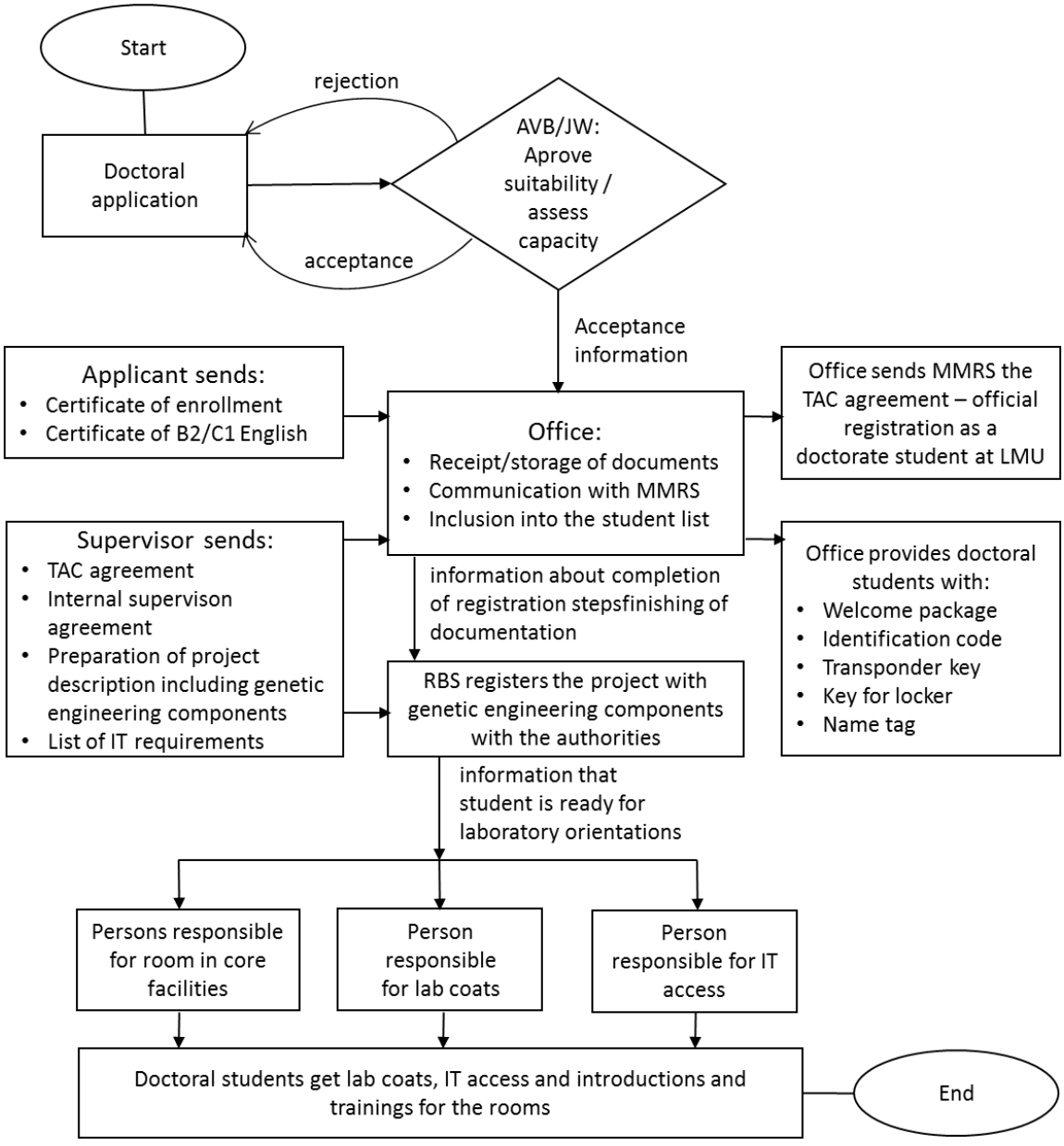

Fig 1. Flow process chart showing administrative steps from application through matriculation to the start of experimental work. AVB – Alexandr V. Bazhin, JW – Jens Werner, MMRS – Munich Medical Research School, TAC – Thesis Advisory Committee, RBS - Representative for Biological Safety.

Table 1. The evaluation test after pre-requisite training to work in a cell culture room

Question	**Response**
1. How often should you examine your cell cultures for evidence of bacterial or fungal contamination?	□ Once a week □ Twice a week □ Every day □ When it is time to passage the cells
2. In case of bacterial and fungal contamination, what are the key steps that have to be taken?	□ Report contamination to the person in charge of the room □ Throw all contaminated cell cultures into the black bin □ Place contaminated cultures in an autoclave bag and autoclave all items before disposal in black bin □ Add Gigasept to the cultures to reach a concentration of 3% for 15 min and then dispose of the liquids in the sink before throwing empty cell cultureware in the black bin □ Alert owners of other cell cultures in the same incubator □ Carry out cleaning and decontamination of incubator
3. What do I do, if I have finished my cell culture experiments for now (for example you are leaving the department)?	
4. Where do I get the cells and media (supplements) that I need?	

Development of the welcome package

To make the beginning of doctorate as easy as possible, the authors designed a so-called "welcome package" which contains important information for starting work in the department as well as describes the sequence of obligatory trainings and briefings. This welcome package is handed over to students at the beginning by the administrative staff. The content of the welcome package is summarized in the Table 2. An exemplar of the document can be obtained from the corresponding author upon request.

Table 2. Content of the welcome package

Content
1. Checklist for instructions and training
2. List of persons responsible for signing off on each step or responsible for rooms in the core facilities.
3. Room plan
4. Useful information and addresses
5. Flow process chart showing steps from registration through matriculation to the start of experimental work (see Fig. 1)
6. Checklist of tasks after completion of medical doctoral degree

Assessment of the key-indicators

As described before, two key-indicators were chosen to evaluate the success of management system developed. The first key-indicator was the duration of the process from the start of official registration as a student until the beginning of his or her practical activity. In three years (2018-2020), 20 applicants were accepted as doctoral students in the Department. Two of them already finished their experimental work and spent 16 and 28 months for their experimental work. The whole package of introductory tasks and trainings is standardized and takes up between eight (8) h and 14 h in duration depending on the complexity of the project. However, the checklist can/should be completed in several days, despite the involvement of different responsible persons. The median duration of the introductory procedure as a whole was 20 days with minimum of 6 and maximum of 121 days (Fig. 2a). In our Department, students can do their theses either in parallel to their medical study or full-time after attaining their undergraduate medical degree. Therefore, it was of interest to determine whether the duration of the introduction is dependent on the modus of the doctorate – full-time or part-time. The analysis revealed no difference in duration of the introductory procedure between students who did it part-time or full-time modus (data not shown).

As mentioned before, the second key-indicator was the pass rate on knowledge tests. The analysis revealed that in four types of trainings (general introduction, training to work in the murine cell culture, protein and molecular biology laboratories; 50% of 8 possible types of trainings), all students passed the tests after the first round of teaching (Fig. 2b). For the other four types of trainings (working in the cell line and primary cell culture laboratories, FACS and histology laboratories), 5-31% of students had to repeat the trainings due to failed evaluation tests. Nobody had to repeat the introduction third time.

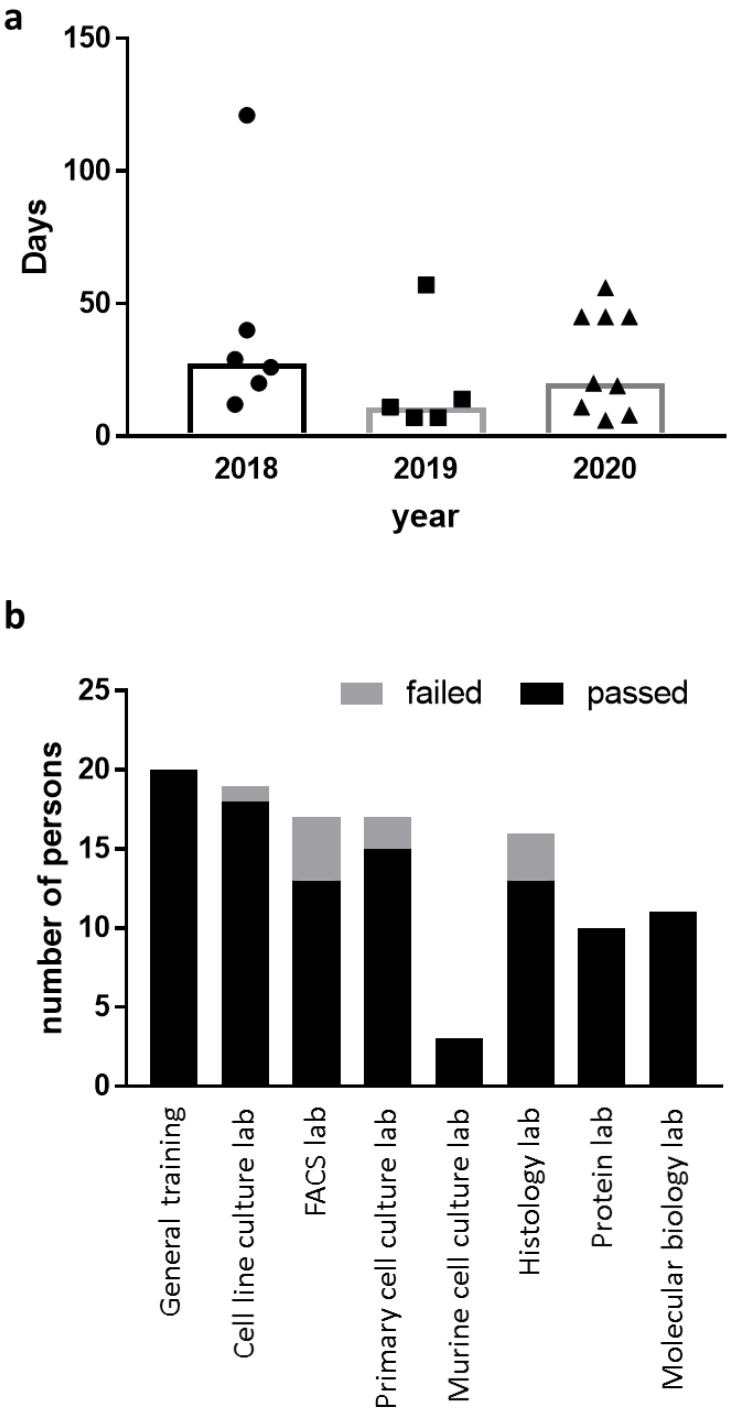

Fig 2. Assessment of key-indicators: a, Duration (in days) required to complete introductory tasks and training from the start of official registration as a student until the beginning of practical activity; b, Number of students passing or failing evaluation tests after their

general training including safety training and pre-requisite training to use the various core facilities.

Discussion

Research and academic freedom is a basic right in Germany and it is enumerated in article §5 of German constitution (Bundesamt für Justiz, 2021). This idea reflects the philosophic tradition of Plato (Nealon, 2009) and Baruch de Spinoza (Heisler, 2007), and is integrated in German universities due to the efforts of Wilhelm von Humboldt (Karran, 2009). The research and academic freedom gives young scientists unending possibilities for their creativity and avenues to realize their ideas. The other side of the coin of freedom is a laissez-faire organization of post-graduate education that fails to reach certain standards. In contrast, legal requirements, depending on scientific projects, are strictly regulated through the German Labor Protection Act (International Labour Organization, 2021) and the Biomedical Regulation Law in Germany (EUREC, 2021) and have to be considered. Hence, the development of quality management systems in general and genetic engineering regulations and biological safety guidelines in medical education in particular is increasingly important from day to day. Therefore, structured doctoral programs in natural science and medicine established in many universities in Germany should consider this aspect.

In our research department which is highly involved in doctoral education, we established a management system for the decentralized administration of medical graduates. This management system was evaluated using two key-indicators: (i) duration of the process from the start of the official registration as a student until the beginning of practical activity and (ii) the pass rate on evaluation tests after training. Since there is no published data detailing development of similar management systems so far to the best of our knowledge, we cannot compare qualitative and quantitative data obtained from this project.

However, reflection about chances and risks of an administrative construct is an indispensable requirement of systems based on the DIN EN ISO 9001-2015. Therefore, the results of our project can be discussed according to the SWOT analysis model (Helms and Nixon, 2010) to optimize the management system established (Fig. 3).

Based on the goal setting theory of Locke and Latham, objectives should be specific and measurable to achieve the best performing results (Locke, 2002). In order to allow review and optimization, special key-indicators that are quantifiable should be settled on. Defined rules and elaborated checklists included in the welcome package reflect the specificity our main goal, which was to establish a decentralized management and administration system for doctorates. Therefore, we consider our chosen key-indicators to be appropriate for monitoring the strengths of our established management system.

The strengths identified can be leveraged to create opportunities (Fig. 3). Firstly, the strengths can help us to standardize initial trainings for medical doctorates and allow us to formalize the trainings as SOPs. Secondly, students receive not only project-specific information, which is of course important for carrying out their doctorate, but they also get important general information (i.e. genetic engineering regulations, biological safety guidelines, safety at work etc). They can use this knowledge for their future scientific work (life-long learning) when they join another laboratory or start their own laboratories. However, the strengths defined before could also open Pandora’s box, which is reflected in the diagram

detailing possible threats (Fig. 3). The main threat from our point of view could be the overregulation of the process leading to higher bureaucracy.

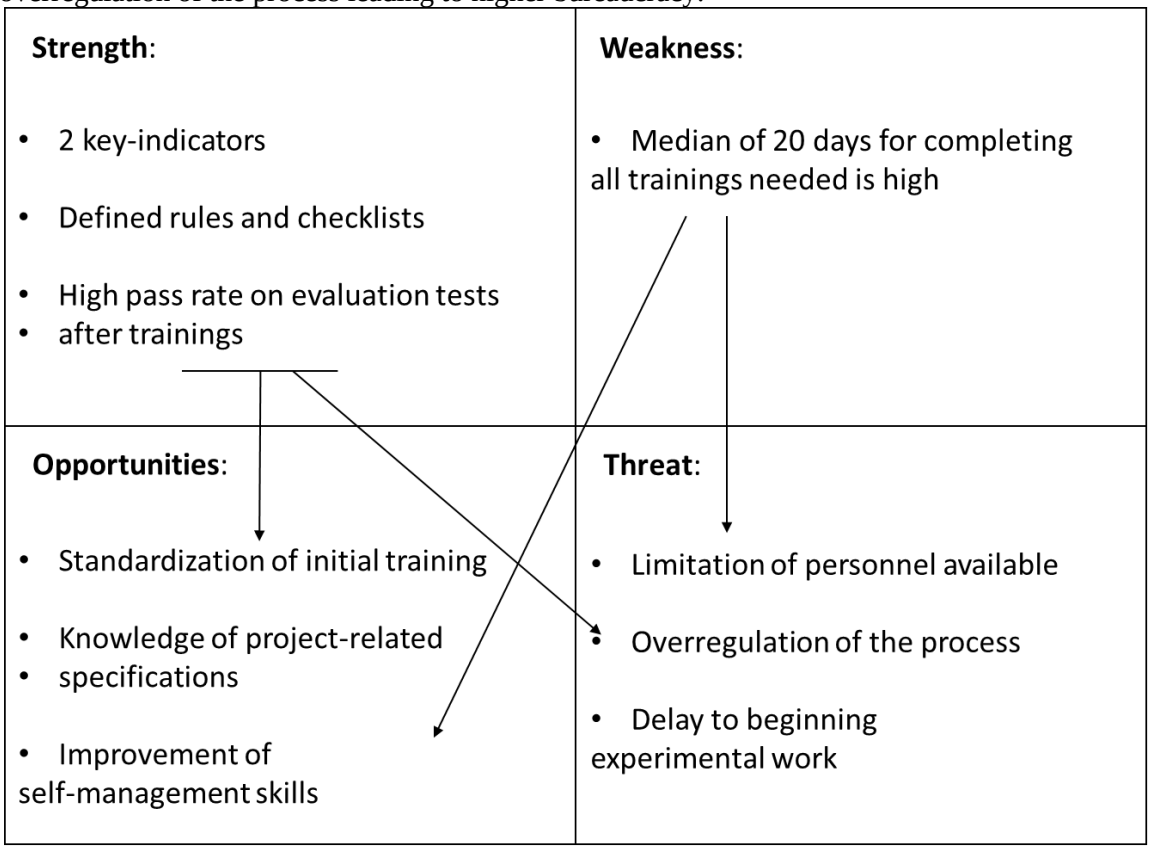

Fig 3. SWOT analysis of the project

Finally, a close look has to be taken at the weakness. We think that a median of 20 days needed for introductory tasks and trainings is high. Nonetheless, the range of the days needed for getting introductions is very large. Since the process for completing their checklist was the same for all students, the duration sheds light on the self-management skills of doctorates. Therefore, shortening of the duration could be seen as an opportunity (Fig. 3). The important threat from the weakness discussed would be limitations in personnel availability for the instruction process. Normally, the instructions and briefings are done by permanent staff, such as scientists and technical assistants. However, these tasks must be done on the side as they do not fall within the main job scope of these individuals. Hence, staff capacity could be overloaded. These two threats mentioned can cause delays to commencement of experimental work, which might result in low motivation at the start of the student's project.

CONCLUSION

In this project we successfully developed a decentralized management and administration system for doctorates. Based on internal evaluations using key-indicators as well as the SWOT

analysis, we can conclude that this management system is of advantage for research facilities that have medical scientific programs for local and international students.

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