



Research article

Model for enhancing the research conducted by the university medical staff: Participatory action research

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ABSTRACT

This study employed mixed methods with a participatory action research approach to explore factors currently undermining the conduction of research and to develop strategies to boost research productivity. A questionnaire was distributed to 64 staff members of the Department of Anesthesiology at a university-based hospital. Thirty-nine staff members (60.9%) gave informed consent and responses. Staff views were also collected through focus group discussions. The staff reported that limited research methodology skills, time management, and complex managerial processes were the limitations. Age, attitudes, and performance expectancy were significantly correlated with research productivity. A regression analysis demonstrated that age and performance expectancy significantly influenced research productivity. A Business Model Canvas (BMC) was implemented to gain insight into the goal of enhancing the conduct of research. Business Model Innovation (BMI) established a strategy to improve research productivity. The concept, comprising personal reinforcement (P), aiding systems (A), and a lifting-up of the value of research (L), the PAL concept, was considered key to enhancing the conduct of research, with the BMC providing details and integrating with the BMI. To upgrade the research performance, the involvement of management is imperative, and future action will involve the implementation of a BMI model to increase research productivity.

1. Introduction

One of the roles of academic instructors in university hospitals is to produce research publications that disseminate knowledge and new discoveries among the global scientific community. Based on the statistical records of the Department of Anesthesiology, Faculty of Medicine, Siriraj Hospital, Mahidol University, the number of research publications produced within the department was found to be inadequate compared with other departments. It has been previously reported that research requirements, if made mandatory, could lead to a threefold increase in research output. Furthermore, integrating research initiatives into healthcare service routines is

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essential, given the continuous innovations in medicine and technology [1]. The literature has suggested a wide range of factors that hinder the conduct of research. They include insufficient knowledge and time, inadequate support from management, a lack of organizational policies that facilitate the execution of research projects, limited funding, and inefficient management of the research process and personnel involved [2–6]. Although several limitations for conducting research have been identified, extant studies have yet to propose a strategic model to overcome them. A previous study on university-based institutions reported that academic instructors generally produced limited research publications, failed to complete data acquisition and analysis in time, or failed to reach their research goals [7]. The workloads of staff at university-based institutions are similar. Not only is the staff responsible for handling a large number of patients in operating theaters but they are also required to supervise undergraduate and postgraduate medical trainees and anesthesia student nurses. However, despite the high workloads, conducting research is crucial. It can lead to enhanced patient service, better trainee education, academic achievements, and contributions to human resource development [8–10].

However, staff members of academic institutions primarily spend their time on medical services and clinical rounds rather than conducting research, for which they might not be sufficiently skilled [11]. Thus, considering that the goal of the Faculty of Medicine, which is to increase the number of research publications, the necessity to initiate a comprehensive strategic plan was realized. Determining the limitations that are faced when conducting research could aid the development of strategies to improve the knowledge, skills, and attitudes related to research and publication output. Three constructs of the Theory of Planned Behavior (TPB) were drawn upon [12]: attitudes, subjective norms or social influence, and perceived behavioral control, leading to intention and behavior. The existing problem with the university medical staff was that their research output needed to be increased. To augment research behavior, barriers to conducting research should be identified. Therefore, the primary objective of this study was to explore the problems and barriers related to initiating and conducting research by staff anesthesiologists. A participatory action research (PAR) model was applied. It focused on problem identification, attitudes toward the problems, and periodic follow-ups, and also drew upon questionnaires and group discussions. This approach was previously evidenced as an effective means of promoting organizational and cultural transformation through knowledge creation and theory integration [13–16]. The secondary objectives were as follows.

- To adopt the Business Model Canvas (BMC) as a conceptual platform for research evaluation, management, and innovation to increase research conduction and productivity [17].
- We implemented the Business Model Innovation (BMI) to create a strategic model for improving research productivity

This study was the first to apply a business managerial system as a tool to improve the conduct of research by university-based medical staff.

2. Materials and methods

2.1. Study design and participants

This cross-sectional study incorporated qualitative and quantitative data collection and analysis (mixed methods) within the PAR framework. This approach has been reported to have more potential for a research team to discuss and gain perspectives on the issues of interest than a single research methodology [18]. Before starting the current study, the protocol was approved by the Ethics Review Committee for Human Research, Siriraj Institutional Review Board (approval number SI 711/2016). The research followed the Committee on Publication Ethics guidelines [19]. Sixty-four staff members of the anesthesiology department of a university hospital were enrolled. Written informed consent to participate was obtained from 39 staff members. According to the literature, it was hypothesized that a difference in age and age-related attitudes could affect the performance of team members of an organization [20,21].

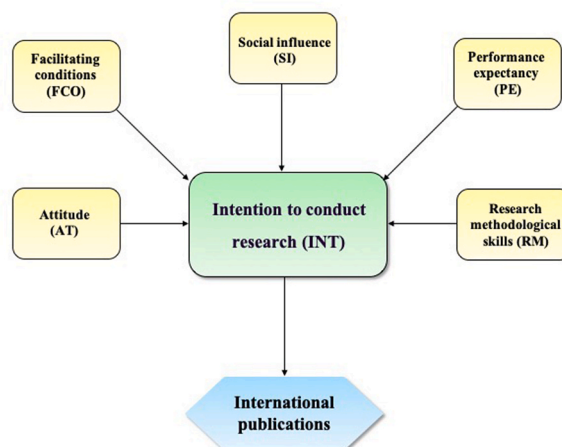


Fig. 1. Conceptual framework.

Therefore, the participants in the study were categorized further into focus groups for discussions according to their generation: Baby Boomers (born between 1946 and 1964); Generation X (Gen X; born between 1965 and 1979); and Generation Y (Gen Y; born between 1980 and 1994) [22,23].

The questionnaire was comprised of three sections. The first section addressed the respondents' demographic profile (sex, age, and years of work) and general characteristics (such as previous research experience and reasons for conducting past research). The second section was constructed according to the TPB (which links beliefs or motivations to intention and behavior), a literature review, and the opinions of experts in the field. By adopting the principle of the TPB, we identified factors that might hinder the conductance of research and created a conceptual framework (Fig. 1). The independent factors were attitudes (AT), research methodology skills (RM), facilitating conditions (FCO), performance expectancy (PE), and social influence (SI). These factors collectively led to the intention to conduct research (INT) and the outcome behavior, which is research productivity and denoted by the number of international research publications. The independent factors AT, SI, and INT corresponded with attitudes, social influence, and intention in the TPB. Three factors, RM, FCO, and PE, were hypothesized based on data from published studies and experts' opinions, and the factors were assumed to belong to perceived behavioral control as the other component of the TPB. Participants responded to the Part 2 questions using a 7-point Likert scale. Finally, the third section of the questionnaire focused on the formulation of methods to increase the research publication output of staff. While Parts 1 and 2 sought responses from individual participants, Part 3 sought staff opinions solicited through focus group discussions (Supplementary-1 (S1)).

The items in the questionnaire were classified according to the conceptual framework. Factors that potentially created problems and barriers to research productivity were based on a literature review and were incorporated into the questionnaire. Staff opinions on those factors were derived from the participants' ratings for the items in the second section of the questionnaire. Therefore, a 7-point Likert scale was used, with a score <4 representing an inclination toward disagreement and a score >4 signifying agreement. A score of 4 was regarded as denoting a neutral opinion.

After the questionnaire was created, three content experts (two faculty executives and one experienced psychologist) evaluated the questions related to problems and obstacles to research and solutions to impediments. Supplementary 2–4 (S2–S4) details each structure's validity and reliability test results from a pilot test. The content validity of the questionnaire was ensured by the index of item-objective congruence (IOC 0.938; S2 Table 1). Subsequently, the questionnaire was distributed to faculty members working in other fields and other institutions to assess the reliability of the questionnaire. Overall, 33 faculty members responded to the questionnaire (S3 Table 2). Cronbach's alpha coefficient determined the internal consistency of the questionnaire. The alpha values for attitudes, RM, facilitating conditions, and intention to conduct research were 0.909, 0.902, 0.912, and 0.969, respectively, indicating a very high degree of acceptability. Although the alpha value for SI was 0.711, indicating good acceptability, the value for PE was only 0.544, which was poor. Overall, all constructs in this study had an alpha coefficient above 0.5, which means that all the questions were reliable and adequate for use as a research instrument [24] (S4 Table 3).

We adopted PAR as a tool for qualitative and creative-based processes to enable the participants to share relevant information and experiences and develop solutions to problems of interest using the questionnaire and focus group discussions. Those anesthesiology staff members who agreed to participate in the study were asked to complete the questionnaires. The questionnaires were distributed to the participants by research assistants and were collected and summarized in January 2017. Focus group discussions were conducted in February 2017, while workshop activities were conducted between March 2017 and January 2020. The focus group sessions were held after office hours at the Department of Anesthesia by a qualified moderator (RP) under the standard focus group discussion protocol [25–27]. The discussion topics addressed barriers to the initiation of research, research productivity, and suggestions for improvement. Each focus group discussion lasted 60–90 min. After all the focus group sessions were completed, 12 workshop sessions were held. They focused on effective RM and the writing of quality proposals and manuscripts. There were 10 additional sessions pertaining to research inspiration, for example, pathways to successful publications, the benefits of conducting research, and ways to encourage oneself to initiate research. The focus group discussions were recorded and transcribed by an external transcriptionist. The number of workshop activities attended by each participant was recorded.

RP further analyzed the information collected from the questionnaires and focus groups through PAR to create the personal reinforcement (P), aiding systems (A), and lifting-up (L) (PAL) model for enhancing research productivity. Moreover, workshop activities were undertaken to support the concept of PAL, encourage participants, overcome barriers to conducting research, and improve research productivity. A strategic plan for improving research productivity was developed by creating BMC and BMI. BMC was designed to create a systematic model to reflect the motivation for research productivity by gathering information from the questionnaires and focus group discussions under the PAL concept. BMI was regarded as a novel strategy for the sustainable improvement of research productivity.

2.2. Statistical analysis

The baseline personal demographic data were analyzed using descriptive statistics and were described as the mean, percentage, and standard deviation. A 7-point Likert scale was used to rate the responses to the questionnaire items dealing with participants' attitudes toward the problems and the perceived obstacles to conducting research. A respondent rating of 1 represented strong disagreement, whereas a rating of 7 represented strong agreement. The Likert scale data were analyzed using mean and standard deviation, which is the recommended approach for identifying the particular traits of a population via a series of questions [28]. Furthermore, a quantitative study was performed by correlation and regression analyses. The correlations between age, the independent factors affecting research productivity, and the number of international research publications were determined by Spearman's rank correlation coefficient. Independent factors affecting research productivity (represented by the number of international research publications) were

analyzed using multiple linear regressions and presented as regression coefficients. The statistical analyses were performed using The International Business Machines Corporation (IBM Corp) Statistical Package for the Social Sciences Statistics for Windows, Version 28.0, Armonk, New York: IBM Corp; 2021. Information from the focus group sessions was used to analyze and summarize the measures that had been proposed to increase research productivity.

3. Results

The questionnaire regarding the obstacles to conducting research was distributed to the staff, and the response rate was 60.94% (39 of 64 staff members). Most of the participants were women (69.2%), Gen X (61.5%), and had research experience (94.9%). The average age and work experience of the 39 staff members were 44.1 ± 8.8 years and 14.9 ± 8.7 years (mean \pm standard deviation), respectively (Table 1). Moreover, PAR was performed for the questionnaires and focus groups. The questionnaires revealed that most participants had little experience (≤ 5 times) as the head or co-author of a research project, as the principal investigator, or as the corresponding author of internationally published research. The reasons for conducting the research varied. The principal reason was personal preference (28.2%), followed by a higher academic position/job promotion (25.6%). The reasons for the participants with multiple answers were combined and regarded as "other" (30.8%). Unfortunately, these multiple responses were too diverse to demonstrate a clear pattern or trend (Table 2).

The workshops consisted of 12 sessions on RM and another 10 sessions on research inspiration. Several experienced and successful researchers led the sessions or participated in the activities. Most of the participants attended ≤ 3 sessions for both RM (59%) and research inspiration (51.3%). After completing the workshop program, assessments were made of the participants' performances in three areas, which were as follows: submission for ethics review, funding applications, and the number of international research publications from the past until after the completion of workshop activities. For each area, the performance of most participants was ≤ 3 (Table 3).

The average scores on the Likert scale of the questionnaire for each of the factors related to the problems of conducting research were similar (>4). However, there were disagreements on some questions, such as the difficulty of entering data using a statistical program, managing time while conducting research, preferences for research versus other medical or academic services, and the importance of incentives to conduct research. All had Likert scale scores of <4 (Table 4). Table 5 details the correlations between participant age and the factors acting as barriers to research and research productivity (the total number of international research publications) from the past until after the completion of all workshops. There were significant positive correlations between age and attitudes, PE, and research productivity. Multiple linear regression analysis demonstrated that age and PE contributed significantly to research productivity (Table 6).

Factors related to the problems and barriers of conducting research were elicited from participants in focus group sessions led by RP and AS, who were the moderator and coordinator, respectively. The factors were categorized according to the conceptual framework (Table 7). Additional factors were also obtained from the focus group discussion, such as a lack of research teamwork and communication between research groups. The factors that were perceived to influence the conduction of research were collectively analyzed to construct the "PAL" concept as described above. This concept was intended to symbolize a "research pal" that provides both corporeal and spiritual assistance for the conduct of research and an attendant increase in productivity. The PAL concept was regarded as key to enhancing the conduct of research.

3.1. Focus groups

The opinions of the participants from different generations were collected from the group discussions. They were analyzed and categorized in the PAL format.

3.1.1. Personal reinforcement (P)

The three fundamental tasks of the Department of Anesthesiology are providing medical services, providing staff education, and

Table 1
Demographic data of the participants.

Variables	n (%) or mean \pm SD
Sex	
Male	12 (30.8)
Female	27 (69.2)
Age (years)	44.1 ± 8.8
Generation	
Baby boomer	6 (15.4)
Generation X (Gen X)	24 (61.5)
Generation Y (Gen Y)	9 (23.1)
Work experience (years)	14.9 ± 8.7
Prior experience doing research	
No	2 (5.1)
Yes	37 (94.9)

n: number; SD: standard deviation.

Table 2
General information on the research productivity of the participants.

Variables	n (%)
Having been the head of research (projects, n)	
0-5	27 (69.2)
6-10	8 (20.5)
>10	4 (10.3)
Having been a co-researcher (projects, n)	
0-5	27 (69.2)
6-10	10 (25.6)
>10	2 (5.1)
Having been a principal investigator/corresponding author of an international publication (projects, n)	
0-5	30 (76.9)
6-10	6 (15.4)
>10	3 (7.7)
Reasons for conducting the research	
Personal preference or interest	11 (28.2)
Proper knowledge of research methodology to integrate into routine teaching or work	4 (10.3)
Pursuit of a higher academic position/job promotion	10 (25.6)
Support from a superior/supervisor	0 (0)
Being forced/requested	2 (5.1)
Other	12 (30.8)

n: number.

Table 3
Activities to improve research productivity and outcomes.

Variables	n (%)
Participation in research activities	
Research methodology (total of 12 sessions)	
0-3	23 (59)
4-6	15 (38.5)
>6	1 (2.6)
Research inspiration (total of 10 sessions)	
0-3	20 (51.3)
4-6	15 (38.5)
>6	4 (10.3)
Performance after focus group meetings	
Research submissions to the institutional ethics review board	
0-3	35 (89.7)
4-6	4 (10.3)
>6	0 (0)
Research funding applications	
0-3	39 (100)
4-6	0 (0)
>6	0 (0)
Total number of international research publications	
0-5	27 (69.2)
6-10	7 (17.9)
>10	5 (12.8)

n: number.

conducting research. Although undertaking research is considered mandatory for academic staff, courses on clinical research and biostatistics are not mandatory in the curriculum. However, occasionally, special talks or lectures on research have been provided for interested staff. Negative attitude toward research is inevitable, specifically among older staff who was not encouraged to conduct research during their early working years. Effective time management to achieve work-life balance goals is crucial for all generations, and difficulty reaching those goals was regarded as one of the chief impediments to conducting research.

Baby Boomer participants.

- Some people believe that people who conduct research are too self-focused because they are likely to be aiming for higher positions or promotions.
- It is important to create a balance between research and personal life rather than focusing solely on research. Having said that it is hard for me to do so.

Gen X participants.

Table 4
Attitudes toward factors related to problems and barriers to conducting research.

Items	Questionnaire	Mean ± SD
AT	Attitudes	5.28 ± 1.17
AT1	I consider that conducting research is interesting.	5.64 ± 1.16
AT2	I consider that conducting research is necessary as a medical school instructor.	5.54 ± 1.39
AT3	I consider that conducting research is worth the resources utilized for the publication of the research.	4.38 ± 1.48
AT4	I consider that conducting research benefits me.	5.72 ± 1.12
AT5	I consider that conducting research benefits others.	5.31 ± 1.45
RM	Research methodology skills	4.56 ± 1.00
RM1	I consider that developing the research question is complicated.	4.64 ± 2.06
RM2	I consider that the research design and statistical analyses are complicated.	4.77 ± 1.90
RM3	I consider that developing this research proposal was complicated.	4.77 ± 1.60
RM4	I consider that the research data collection is complicated.	4.85 ± 1.65
RM5	I consider that entering data into a program for statistical analysis is complicated.	3.72 ± 1.38
RM6	I consider that data analysis and statistical interpretation are complicated.	4.36 ± 1.61
RM7	I consider that writing the original article is complicated.	5.33 ± 1.63
FCO	Facilitating conditions	5.05 ± 1.00
FCO1	I consider that the steps of research document processing by the Department of Anesthesiology are complicated.	4.18 ± 1.79
FCO2	I consider that requesting approval from the Ethics Review Committee for Human Research of the Institutional Review Board is complicated.	4.72 ± 1.50
FCO3	I consider that research grant proposals are complicated.	5.59 ± 1.45
FCO4	I consider that requesting data from the Department of Anesthesiology's database is complicated.	4.72 ± 1.57
FCO5	I consider that requesting data from the Hospital's central database is complicated.	4.67 ± 1.61
FCO6	I consider that submitting an article for publication is complicated.	5.90 ± 1.37
PE	Performance expectancy	4.38 ± 1.14
PE1	I am capable of conducting research.	4.90 ± 1.70
PE2	I can manage my time for other activities while conducting research.	3.41 ± 2.04
PE3	I prefer conducting research to performing academic or medical service duties.	3.95 ± 1.97
PE4	Having a research support unit is important for my research.	6.10 ± 1.27
PE5	Having a reward/an incentive to do research is an important motivation for me.	3.05 ± 1.95
SI	Social influence	4.95 ± 1.17
SI1	The head of the Department of Anesthesiology encouraged all staff to conduct research.	5.53 ± 1.25
SI2	My peers in other departments in the hospital agree that it is good that all staff conduct research.	4.32 ± 1.45
SI3	It is good that all staff members of the Department of Anesthesiology conduct research.	4.47 ± 2.01
SI4	It is good that the Faculty of Medicine requires me to have my research published.	4.43 ± 1.63
SI5	The policy of the Faculty of Medicine supporting the conduct of research affects my research.	5.31 ± 1.62
SI6	Persuasion from colleagues or people with experience in doing research affects my research.	5.92 ± 1.17
INT	Intention to conduct research.	5.56 ± 1.80
INT1	I expect to conduct research within the next 6 months.	5.62 ± 1.94
INT2	I am determined to conduct research within the next 6 months.	5.77 ± 1.81
INT3	I would like to finish a research proposal within the next 6 months.	5.38 ± 1.98

AT: attitude; FCO: facilitating conditions; INT: intention to conduct research; PE: performance expectancy; RM: research methodology skills; SD: standard deviation; SI: social influence.

Table 5
Correlations between independent factors affecting problems and barriers to conducting research and the number of international research publications.

Independent factors	r	p-value
Age	0.404	0.011*
Attitudes	0.416	0.008**
Research methodology skills	-0.274	0.091
Facilitating conditions	-0.011	0.948
Performance expectancy	0.382	0.016*
Social influence	0.129	0.434

r: Spearman's rank Correlation Coefficient.

*Correlation is significant at the 0.05 level.

**Correlation is significant at the 0.01 level.

- I want to conduct research, but I am not sure if my research design is correct. The staff that has statistical knowledge could assist others.
- It may be considered inappropriate if people put aside their general service duties to collect research data.
- Time management is a major problem for me. I feel that I am being forced to do research these days.

Table 6

Multiple linear regression analysis of independent factors contributing to the number of international research publications.

Independent factors	Number of research publications		
	B	Standard error	p-value
Age	0.268	0.086	0.004**
Attitudes	1.755	0.891	0.057
Research methodology skills	-0.329	0.841	0.698
Facilitating conditions	0.886	0.782	0.265
Performance expectancy	1.898	0.799	0.024*
Social influence	-1.659	1.000	0.107

B: Beta Coefficient.

*Significant at p-value <0.05.

**Significant at p-value <0.01.

Table 7

Factors related to problems and barriers to conducting research obtained from focus group discussions.

Factors	Details from focus group discussions
1. Attitude (AT)	Negative attitudes to research
2. Research methodology skills (RM)	Lack of knowledge and skills
3.	No creativity
4. Facilitating conditions (FCO)	No facilitation
5.	Disorganized support systems
6. Performance expectancy (PE)	No monitoring system
	Ineffective time management (no work-life balance)
7. Social influence (SI)	No motivation
	Being stressed/forced
	Unclear faculty policies
	No recruitment objectives
	No mentoring system
	Lack of encouragement from colleagues
	Lack of a friendly research environment
8. Others	No research teamwork
	No communication between research groups

AT: attitude; FCO: facilitating conditions; INT: intention to conduct research; PE: performance expectancy; RM: research methodology skills; SI: social influence.

Gen Y participants.

- Attitude is the hardest thing to modify. Motivation is one of the measures to improve attitude. Despite the overwhelming workload, good attitudes can overcome any obstacles. The only problem for me at the moment is time management.
- To conduct good research, there should be time to train on the job. We need to have adequate experience and knowledge to produce good-quality research.

3.1.2. Aiding systems (A)

Establishing a system to support research performance and the eventual publication of the research findings can take time and effort. The Faculty of Medicine has provided a steadily increasing level of support. For example, statisticians are now available for consultation, and the research division has introduced support with learning about RM, experimental design, and manuscript writing. The Department of Anesthesiology has also established its own research office. Research assistants are available to help researchers with administrative matters, including manuscript preparation and submission. Nevertheless, the Faculty of Medicine and the Department of Anesthesiology policies were seen by some staff as needing clarification regarding the overriding purpose of conducting research and the requirement for staff to carry out research. Furthermore, a formal research mentoring system is yet to be developed.

Baby Boomer participants.

- If the department offers more support or time for expert consultations, our staff can ask questions and learn how to do good research. Currently, I feel that I need additional support from the department.
- We do not have a clear mentoring system. The Department of Anesthesiology assisted with the administrative system and time allocation. Nevertheless, I am not sure if this can solve all of our problems.

Gen X participants.

- Does the department require that all staff do research?
- I am not sure about the faculty policy. The faculty has frequently emphasized patient service tasks. We are working in a university hospital where research is not the only thing to be prioritized.
- It is not only academic staff who need support from the department; nurses also need support as they can conduct research. However, it appears that nurses do not have a research support system.
- If an administrative person could help with any research matters, that would be great.

Gen Y participants.

- We need someone who acts as a babysitter to assist in the conduct of research by giving advice, sharing experiences, and providing motivation.
- I have no idea who to contact in the department’s research office and what they actually do.

3.1.3. *Lifting-up (L)*

There are 29 clinical and preclinical departments in the Faculty of Medicine. Collaboration between them is not apparent, particularly between the clinical and preclinical departments. Within the Department of Anesthesiology, services are separated according to subspecialty, for instance, neuroanesthesia, obstetrics–gynecology anesthesia, cardiovascular–thoracic anesthesia, and chronic pain clinics. Therefore, research on subspecialties is the main focus, and such studies are conducted in small, closed groups. Few extensive partnerships have been formed, and encouragement from colleagues with different interests is not evident.

Baby Boomer participants.

- The departments in the Faculty of Medicine are facing problems providing a proper environment and adequate support for research.

Gen X participants.

- There will always be someone who raises objections during the research initiation process. It would be great if we had an environment filled with positive energy.

Gen Y participants.

- If there is a person who encourages and motivates us, it will be easier to achieve good research.

3.2. *Establishment of BMC*

The information collected from the questionnaires and focus group discussions through the PAR method was incorporated into the

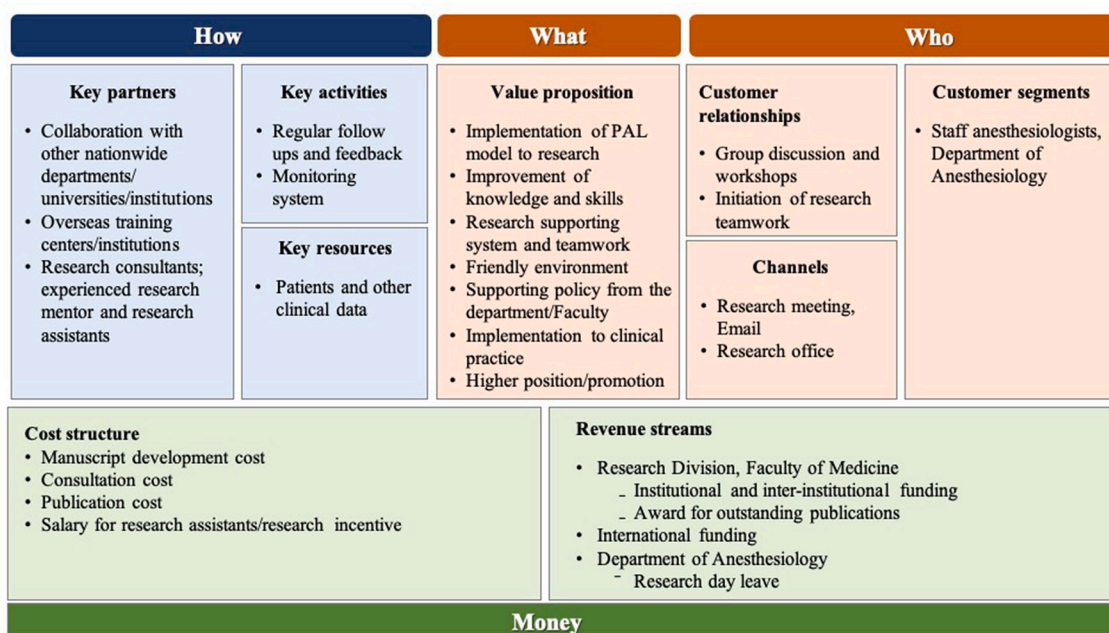


Fig. 2. Business model canvas (BMC).

BMC for research (Fig. 2). The BMC is a tool that describes business components as nine compartments in a single table. The tool aims to ensure that staff within an organization can readily comprehend measures to achieve research goals. Notably, the BMC can also help executive managers of the faculty and the department to gain a global overview, thereby facilitating the development of effective strategic planning. This study displayed the BMC of the infrastructure related to research in the Department of Anesthesiology in a university hospital.

Customer segments: The primary customer group is the Department of Anesthesiology academic staff. These staff members are the target group that must carry out research and publish research findings for different purposes. These include a personal preference for research, pursuing a job promotion, and complying with the department and faculty requirements. Currently, the Department of Anesthesiology staff is composed of a mix of generations: Baby Boomers, Gen X, and Gen Y.

Value proposition: The key approach to enhancing research performance and increasing publication output lies in implementing the PAL concept. Upon its introduction, several areas will be strengthened. For example, individual research knowledge and skills will improve, tangible support and mentoring systems will be provided, teamwork will be fostered, and an environment that actively supports and promotes research will be created. Applying research outcomes to clinical practice would also be encouraged, reinforcing the importance of research in positively enhancing routine patient care. Another persuasive argument supporting the undertaking of research is that it may lead to job promotion within the department or the faculty.

Channels: Effective communications between staff anesthesiologists and either the Department of Anesthesia or the Faculty of Medicine could be achieved through research meeting sessions or email messaging. The Department of Anesthesiology's research office is another channel available to facilitate staff networking within the department or faculty. The research office could also help by communicating updates on research news and policies from management to departmental staff.

Customer relationships: To encourage staff anesthesiologists to participate actively in research, it is proposed that group discussions and workshops on research start-ups, methodologies, and inspiration should be held. Furthermore, forming research teams of staff with similar interests is a complementary approach that could be deployed.

Key resources: An invaluable resource available within the Department of Anesthesiology is the clinical and scientific data collected from patients and other participants. Information related to patients' demography and clinical courses is routinely recorded on paper or electronically at admission and hospital visits and is ready to be utilized.

Key activities: To maintain a satisfactory level of research and to promote high productivity, regular monitoring and feedback by the Research Committee of the Department of Anesthesiology would be necessary. This could be achieved through scheduled research progression meetings. The department could also establish a formal monitoring system in which assigned mentors give advice and guide the direction of a study to facilitate its completion within a set timescale.

Key partners: Materials for research, such as clinical and scientific data, could be shared between partner institutions throughout Thailand. Experimental and technical support could also be obtained from partner institutions within Thailand and overseas. Collaborating research centers in other countries might also offer training opportunities for staff who aim to develop research with high-yield publication quality. Additionally, the Department of Anesthesiology could provide research consultation support by arranging for experienced mentors and research assistants to offer advice and assist with troubleshooting during a research project.

Cost structure: The costs for the research process (from research design to eventual publication) include expenditure on manuscript development, consultation, publication, salaries and incentives for research assistants, and incentives for participants. Various sponsors, such as the Faculty of Medicine, international institutions, and companies in the private sector, could potentially fund the costs.

Revenue streams: There is the potential for some research projects to generate revenue that could be used to compensate for the costs of funding them by various sponsors. High-quality studies (indicated by the ranking and impact factor of journals in which they are published) are potential candidates for awards for outstanding research granted by the Faculty of Medicine and national authorities. Furthermore, the Department of Anesthesiology could offer research day leave to reward staff producing high-quality research publications.

4. Discussion

Doing research is challenging, as is maintaining the level of research productivity. Previous studies reported several barriers to initiating healthcare research in developing countries [29–35]. These include work, overloads, limited funding, inadequate human and financial capacity, poor research knowledge, absence of a research culture, lack of time and motivation, inadequate supportive systems, and poorly defined research policies [30–37]. In comparison, the barriers to conducting research in developed countries were inaccessibility to research supervisors or mentors, a lack of biostatistical support, insufficient time, inadequate research experience, and a lack of supportive enthusiasm from colleagues [32,35]. The common factors in developed and developing countries are the need for more time, knowledge, and motivation. All these systemic and individual barriers contributed toward the limitation of conducting research and attaining good productivity. Research output is expected to increase with the removal of these barriers.

Currently, medical research capacity is reported to be unequally distributed. Less than 35% of research authors are from middle-income countries, including Thailand [38–40]. The reasons behind this disproportionate research productivity were comparable to what is proposed in this study, which is a lack of knowledge and experience, the absence of a mentoring system, unclear research policies, and no facilitating systems [38].

This study's questionnaire drew upon information from the literature on problems and barriers to conducting research and hypotheses from experts in the field. The TPB, which links attitudes and subjective norms toward the behavior of undertaking research, was utilized to create a conceptual framework. The independent variables in the questionnaire were categorized by the hypothesized

factors under the principle of the TPB. There were positive results (Likert scale scores >4) for both the participants' attitudes toward research and encouragement from the department and faculty for the conduct of research. However, there were also clear barriers (Likert scale scores <4) that may hinder research. Except for addressing data entry into statistical analysis programs, personal skills were generally considered insufficient. Examples of deficient skills are observed in formulating research questions, research design, data analysis, developing proposals, collecting data, statistical interpretation, and manuscript writing. Participants also generally agreed that research involved numerous complicated steps (document processing, obtaining Institutional Review Board approval, grant proposal development, requesting data from departmental and hospital databases, and article submission). Furthermore, research performance seemed impaired by a lack of time management and a preference for undertaking academic activities other than research. Overall, it can be assumed that RM skills and PE are crucial factors that must be emphasized.

The correlation analyses showed that the older participants had, not surprisingly, published the most international studies. Nevertheless, Gen X had the highest research output during the workshops (March 2017–January 2020), averaging 1.9 research publications per person. Past studies have confirmed that the number of biomedical sciences publications peak for the Gen X group, or approximately 25–30 years since attaining a terminal academic degree [41]. This result implies that older staff members might be less incentivized by monetary gains or status than younger generations [42]. Hence, the older staff members were not concerned about undertaking research to gain a job promotion. Another possible explanation was the difficulty of keeping up with new technology [43, 44], including perhaps the more complex research software now available. Therefore, it may be necessary to provide technical assistance to more senior department members. Relative to Baby Boomers, Gen Y are more knowledgeable about the usage of novel digital tools and devices [44]. Although career success is one of Gen Y's top motivations, they might not be equally supported by the workplace compared with their older colleagues [45,46]. This lack of support could affect the productivity of this generation. Additionally, the positive correlations between attitudes and PE and research productivity imply that staff with positive attitudes toward conducting research, confidence in conducting research, and the ability to manage time effectively are more likely to have higher research productivity.

Older age corresponded with more years of working experience. Hence, it was not surprising from the regression analysis that age contributed to research productivity. This was because higher the number of years of work experience, the higher the likelihood of having research published. PE, specifically the ability to manage time to attain a satisfactory work–life balance, could be another crucial factor influencing an increase in research output. This result is supported by the TPB. Each of its three main components, attitudes, subjective norms or SI, and perceived behavioral control, link to intention and, in turn, behavior. However, intention does not always lead to behavior [47]. Instead, perceived behavioral control better reflects actual behavior because it refers to an individual's confidence in successfully performing a behavior with organizational support [12]. The regression analysis was consistent with what was proposed by the theory and an earlier study [48] in the sense that PE was the most potent factor directly influencing intention and behavior, which is what the current investigation termed "research productivity." Our results imply that Gen X was the most productive group during the study period. The Baby Boomers and Gen Y were found to be less productive; moreover, they required technological and workplace support systems, respectively. For each of the three generation groups, PE was the core factor influencing good research productivity.

Using PAR for the focus groups, the current investigation found factors similar to those described by other researchers [25,29–35]. However, some factors had not been mentioned elsewhere. These were negative attitudes toward doing research, self-perceptions of inadequate research creativity, the lack of a monitoring system, the absence of teamwork, and nonexistent communication between research groups. An interesting feature of the present study is that PAR could be used to create the PAL concept and BMC, both of which could enhance research. A recent publication suggested that studies related to the social science field tend to be only of academic value and interest. Conversely, industry-based research can produce practical, real-world, and beneficial knowledge through value creation to fulfill the needs of society [49]. A study by Sparre et al. presented the idea that effective management in the modern era relied on having the capability to initiate and maintain sustainable change in an organization. Therefore, applying industrial concepts to create organizational changes could be beneficial. Moreover, PAR was utilized to create a business model whose values could subsequently be implemented in the process of BMI to devise a strategy for improving productivity [50]. By adopting this concept, a BMC was created from the information acquired after focus group discussions through PAR engagement with the academic members of the Department of Anesthesiology.

Furthermore, PAR was previously reported to be one of the methods used to gather data from involved practitioners to develop values and a strategic plan for BMI and other managerial dimensions [49,51]. BMI is considered to cause immense changes in organizational processes and to differ markedly from existing organizational improvement methods [52]. The present study incorporated information from the PAL concept and BMC to create BMI (Fig. 3). Drawing upon the three pillars of PAL (personal reinforcement, aiding systems, and lifting-up) and the strategic details yielded by the BMC, a strategy was developed to encourage more research within the organization. This process could change the attitudes and behavior of academic staff in the department toward undertaking research, thereby resulting in higher research productivity.

The strength of this study is that it is the first to shed light on the connection between PAR, BMC, and BMI in explaining the problems of conducting research and developing strategies aimed at improving the research productivity of a university hospital. This work is also the first to propose a strategic model to enhance research productivity. This approach differs from previous studies in that they only reported the barriers to research, assuming that research performance would be improved after removing the primary barriers.

One of the study's limitations was the limited time for focus group discussions. Consequently, not every participant was motivated to offer their perceptions of the factors acting as barriers to doing research. Additionally, most participants attended ≤ 3 workshop activities on either RM or inspiration. These limitations might result in some information that could identify additional factors

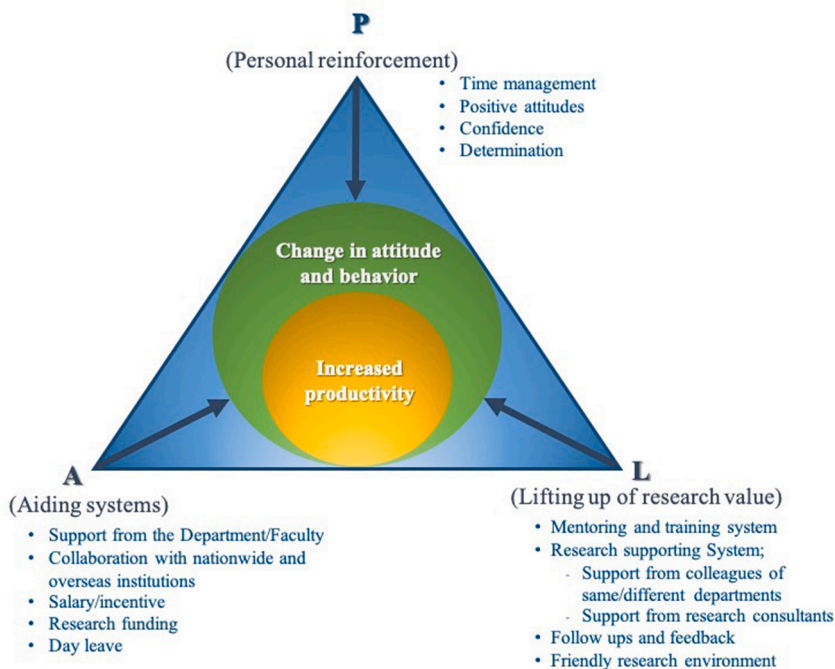


Fig. 3. Business Model Innovation (BMI) for an increment of research productivity.

affecting research being overlooked. Future research on applying BMI to the research context and identifying outcomes in terms of research initiation and productivity is paramount.

5. Conclusions and future work

This work focused primarily on using PAR to determine the barriers to research and to help design a BMC to oversee plans for the advancement of conducting research. Ultimately, BMI was created to outline a novel strategy to improve the research productivity of the Department of Anesthesiology of a university hospital. Future research could adopt this strategy within the Department of Anesthesiology and other departments in the Faculty of Medicine and evaluate the research output. The expected outcomes after applying BMI to the research culture of the organization are an increase in the number of research publications and greater acceptance of the need to undertake research.

Author contribution statement

Arunotai Siriussawakul and Pawit Somnuke: Conceived and designed the experiments; Analyzed and interpreted the data; Wrote the paper.

Rungnapa Panitrat and Patchareya Nivatpumin: Conceived and designed the experiments; Analyzed and interpreted the data.

Pornpuns Punpocha, Ploythai Punikhom and Nichapat Thongkaew: Performed the experiments; Contributed reagents, materials, analysis tools or data.

Chayanan Thanakiattiwibun and Rachaneekorn Ramlee: Analyzed and interpreted the data.

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Data availability statement

Nil.

Declaration of interest's statement

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary data related to this article can be found at <https://doi.org/10.1016/j.heliyon.2023.e13208>.

References

- [1] P. Papasavas, D. Filippa, P. Reilly, R. Chandawarkar, O. Kirton, Effect of a mandatory research requirement on categorical resident academic productivity in a university-based general surgery residency, *J. Surg. Educ.* 70 (6) (2013) 715–719.
- [2] H. Pitout, Barriers and strategies to increase research involvement of South African occupational therapists, *J. South African J. Occupat. Therapy* 44 (2014) 17–21.
- [3] A.V. Neale, P. West, L. French, Surviving your resident research requirement, *JAMA* 280 (20) (1998) 1802.
- [4] A.Y. Shin, C.S. Almond, R.C. Mannix, C.N. Duncan, M.B. Son, H.M. McLauchlan, et al., The Boston Marathon Study: a novel approach to research during residency, *Pediatrics* 117 (5) (2006) 1818–1822.
- [5] L.G. Shewan, J.A. Glatz, C.C. Bennett, A.J. Coats, Contemporary (post-Wills) survey of the views of Australian medical researchers: importance of funding, infrastructure and motivators for a research career, *Med. J. Aust.* 183 (11–12) (2005) 606–611.
- [6] S. Sabzwari, S. Kausar, A.K. Khuwaja, Experiences, attitudes and barriers towards research amongst junior faculty of Pakistani medical universities, *BMC Med. Educ.* 9 (2009) 68.
- [7] T. Charernboon, M. Phanasathit, Research of young psychiatrists: a survey on research status, experiences and barriers to research, *J. Psychiat. Associat. Thailand* 56 (2) (2011) 189–200.
- [8] B. Haynes, A. Haines, Barriers and bridges to evidence based clinical practice, *BMJ* 317 (7153) (1998) 273–276.
- [9] N.W. Goodman, Does research make better doctors? *Lancet* (London, England) 343 (8888) (1994) 59.
- [10] B.C. Abreu, S.M. Peloquin, K. Ottenbacher, Competence in scientific inquiry and research, *Am. J. Occup. Ther.: Official Publicat. Am. Occup. Therapy Associat.* 52 (9) (1998) 751–759.
- [11] M. Al-Tannir, I. Alfayyad, A. Abu-Shaheen, A. Al-Badr, F. Al Mousawi, Clinical research skills assessment: an investigation into the determinants of effective research, *Cureus* 9 (11) (2017), e1870.
- [12] I. Ajzen Attitudes, Personality and Behaviour, second ed., Open University Press, Berkshire, 2005.
- [13] M. Sparre, Utilizing participatory action research to change perception about organizational culture from knowledge consumption to knowledge, *Creation* 10 (1) (2020), 2158244019900174.
- [14] P. Reason, Bradbury H, chapter 2 - participatory action research as practice, in: P. Reason, H. Bradbury (Eds.), *The SAGE Handbook of Action Research*, second ed., SAGE Publications, Ltd, 2008, pp. 31–48.
- [15] A. McIntyre, Chapter 1 - participatory action research, in: A. McIntyre (Ed.), *Participatory Action Research*, SAGE Publications, Inc, Thousand Oaks, California, 2008, pp. 1–14.
- [16] S. Abayneh, H. Lempp, B.A. Kohrt, A. Alem, C. Hanlon, Using participatory action research to pilot a model of service user and caregiver involvement in mental health system strengthening in Ethiopian primary healthcare: a case study, *Int. J. Ment. Health Syst.* 16 (1) (2022) 33.
- [17] A. Osterwalder, Y. Pigneur, Chapter 1 - Canvas, in: A. Osterwalder, Y. Pigneur (Eds.), *Business Model Generation: a Handbook for Visionaries, Game Changers, and Challengers*, John Wiley and Sons, Hoboken, New Jersey, 2010, pp. 44–55.
- [18] M.C. Sendall, L.K. McCosker, A. Brodie, M. Hill, P. Crane, Participatory action research, mixed methods, and research teams: learning from philosophically juxtaposed methodologies for optimal research outcomes, *BMC Med. Res. Methodol.* 18 (1) (2018) 167.
- [19] C. Graf, E. Wager, A. Bowman, S. Fiack, D. Scott-Lichter, A. Robinson, Best practice guidelines on publication ethics: a publisher's perspective, *Int. J. Clin. Pract. Suppl.* 61 (152) (2007) 1–26.
- [20] D.v. Knippenberg, M.C. Schippers, Work group diversity, *Annu. Rev. Psychol.* 58 (1) (2007) 515–541.
- [21] F.J. Gellert, R. Schalk, Age-related attitudes: the influence on relationships and performance at work, *J. Health Organisat. Manag.* 26 (1) (2012) 98–117.
- [22] V.N. Williams, J. Medina, A. Medina, S. Clifton, Bridging the millennial generation expectation gap: perspectives and strategies for physician and interprofessional faculty, *Am. J. Med. Sci.* 353 (2) (2017) 109–115.
- [23] C.L. Betz, Generations X, Y, and Z, *J. Pediatr. Nurs.* 44 (2019) A7–a8.
- [24] K.S. Taber, The use of cronbach's alpha when developing and reporting research instruments in science education, *Res. Sci. Educ.* 48 (6) (2018) 1273–1296.
- [25] How to conduct focus groups: researching group priorities through discussion, *Dev. Commun. Rep.* 77 (1992) 5.
- [26] J.P. Kahan, Focus groups as a tool for policy analysis, *Anal. Soc. Issues Public Policy* 1 (1) (2001) 129–146.
- [27] M.L. Williamson A, Participation, interview guide and running a focus group, in: *Focus Group Protocol Guide: A Guide to Organizing Effective Focus Groups and Getting the Most from the Data You Collect, Democratize*, 2013, pp. 2–8. <http://democrati.se/docs/Democratise.FocusGroupGuide.pdf>.
- [28] H.N. Boone, D.A. Boone, Analyzing Likert data, *J. Ext.* 50 (2) (2012) 1–5.
- [29] N. Al-Yateem, J. Griffiths, M. McCreaddie, S. Robertson-Malt, D. Kuzemski, J. Mathew Anthony, et al., A national scoping study on barriers to conducting and using research among nurses in the United Arab Emirates, *Polit. Nursing Pract.* 20 (4) (2019) 216–227.
- [30] C. Alemayehu, G. Mitchell, J. Nikles, Barriers for conducting clinical trials in developing countries- a systematic review, *Int. J. Equity Health* 17 (1) (2018) 37.
- [31] M. Ataei, A. Hesamzadeh, M. Kheradmand, Research barriers from experts' viewpoints who attended the research workshops of Mazandaran University of Medical Sciences, *J. Med. Life* 8 (4) (2015) 12–17.
- [32] Canadian Plastic Surgery Research Collaborative, Barriers and attitudes to research among residents in plastic and reconstructive surgery: a national multicenter cross-sectional study, *J. Surg. Educ.* 74 (6) (2017) 1094–1104.
- [33] K.A. Dhalla, M. Guirguis, Barriers and incentives for conducting research amongst the ophthalmologists in Sub-Saharan Africa, *PLoS One* 13 (10) (2018), e0197945.
- [34] I. Ichsan, N. Wahyuniati, R. McKee, L. Lobo, K. Lancaster, L. Redwood-Campbell, Attitudes, barriers, and enablers towards conducting primary care research in Banda Aceh, Indonesia: a qualitative research study, *Asia Pac. Fam. Med.* 17 (2018) 8.
- [35] A. Olausson, P.A. Jennings, G. O'Reilly, B. Mitra, P.A. Cameron, Barriers to conducting research: a survey of trainees in emergency medicine, *Emerg. Med. Australasia (EMA) : Emerg. Med. Australasia (EMA)* 29 (2) (2017) 204–209.
- [36] H. Abu-Odah, N.B. Said, S.C. Nair, M.J. Allsop, D.C. Currow, M.S. Salah, et al., Identifying barriers and facilitators of translating research evidence into clinical practice: a systematic review of reviews, *Health Soc. Care Community* 30 (6) (2022) e3265–e3276.

- [37] B.K. Tirupakuzhi Vijayaraghavan, E. Gupta, N. Ramakrishnan, A. Beane, R. Haniffa, N. Lone, et al., Barriers and facilitators to the conduct of critical care research in low and lower-middle income countries: a scoping review, *PLoS One* 17 (5) (2022), e0266836.
- [38] G. Bowsher, A. Papamichail, N. El Achi, A. Ekzayez, B. Roberts, R. Sullivan, et al., A narrative review of health research capacity strengthening in low and middle-income countries: lessons for conflict-affected areas, *Glob. Health* 15 (1) (2019) 23.
- [39] A. Imam, O. Wariri, T. Dibbasey, A. Camara, A. Mendy, A.N. Sanyang, et al., Conducting clinical research in a resource-constrained setting: lessons from a longitudinal cohort study in the Gambia, *BMJ Global Health* 6 (8) (2021), e006419.
- [40] A.R. Iyer, Authorship trends in the lancet global health, *Lancet Global Health* 6 (2) (2018) e142.
- [41] W. Savage, A. Olejniczak, Do senior faculty members produce fewer research publications than their younger colleagues? Evidence from Ph.D. granting institutions in the United States, *Scientometrics* 126 (2021) 1–28.
- [42] T. Kollmann, C. Stöckmann, J.M. Kensbock, A. Peschl, What satisfies younger versus older employees, and why? An aging perspective on equity theory to explain interactive effects of employee age, monetary rewards, and task contributions on job satisfaction, *Hum. Resour. Manag.* 59 (1) (2020) 101–115.
- [43] S. Czaja, N. Charness, A. Fisk, C. Hertzog, S. Nair, W. Rogers, et al., Factors predicting the use of technology: findings from the center for research and education on aging and technology enhancement (CREATE), *Psychol. Aging* 21 (2006) 333–352.
- [44] E. Vaportzis, M.G. Clausen, A.J. Gow, Older adults perceptions of technology and barriers to interacting with tablet computers: a focus group study, *Front. Psychol.* 8 (2017) 1687.
- [45] C. Bratt, D. Abrams, H.J. Swift, Supporting the old but neglecting the young? The two faces of ageism, *Dev. Psychol.* 56 (5) (2020) 1029–1039.
- [46] A. Bencsik, T. Juhász, G. Horvath-Csikos, Generations at workplaces, Y and Z, *J. Competit.* 6 (2016) 90–106.
- [47] T.L. Webb, P. Sheeran, Does changing behavioral intentions engender behavior change? A meta-analysis of the experimental evidence, *Psychol. Bull.* 132 (2) (2006) 249–268.
- [48] P. Philippi, H. Baumeister, J. Apolinário-Hagen, D.D. Ebert, S. Hennemann, L. Kott, et al., Acceptance towards Digital Health Interventions – Model Validation and Further Development of the Unified Theory of Acceptance and Use of Technology, vol. 26, 2021.
- [49] I. Han, S.-T. Hou, Methodology: participatory action research via industry-academia collaboration, in: I. Han, S.T. Hou (Eds.), *Social Innovation and Business in Taiwan*, Palgrave Macmillan US, New York, 2016, pp. 29–36.
- [50] M. Sparre, O.H. Rasmussen, M. Fast (Eds.), *Can Participatory Action Research Create Value for Business Model Innovation? the XXVIII ISPIM Innovation Conference 2017*, Vienna, Austria, 2017.
- [51] G. Matthias, S. Nathalie, K. Anton, A discipline-spanning overview of action research and its implications for technology and innovation management, *Technol. Innov. Manag. Rev.* 9 (4) (2019).
- [52] N.J. Foss, T. Saebi, Chapter 1 - business models and business model innovation: bringing organization into the discussion, in: N.J. Foss, T. Saebi (Eds.), *Business Model Innovation: the Organizational Dimension*, Oxford University Press, Oxford, 2015, pp. 1–23.