Heliyon 7 (2021) e06024

Contents lists available at ScienceDirect

Heliyon

journal homepage: www.cell.com/heliyon

Research article

# Effects of institutional policies and characteristics on research productivity at Vietnam science and technology universities

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ARTICLE INFO

*Keywords:*
Research productivity
Institutional policy
University
Vietnam

ABSTRACT

This study aimed to evaluate the impact of institutional research promoting policies and organizational characteristics on research productivity in Vietnam universities. The authors employed a dataset surveying faculty staff from 115 universities across the country and used multivariate data analysis to analyse data and test hypotheses. It was found that institutional characteristics such as size, time in operation and advantageous location were positively associated with research productivity. Specifically, universities located in the big cities with longer time in operation and larger size had higher level of international publication. Institutional policies such as management and infrastructure had a positive impact on research productivity while human resource policies had a positive impact on faculty research outcomes. The study also provided some suggestions to promote research productivity of Vietnam universities.

## 1. Introduction

Research productivity plays a central role in higher education institution development[1]. Research productivity helps improve teaching quality as there exists a strong nexus between teaching and research effectiveness (Desselle et al., 2018). At the same time, research productivity helps develop knowledge and shape higher education institutions' reputation and brand names. In actual fact, Porter and Toutkoushian (2006) found that faculty research productivity was positively related to university reputation.

In recent years, there has been a competition among Vietnamese higher education institutions to improve their research capability. In 2018, the number of annual international publications in Vietnam reached 10,000 articles. For the year 2018, in comparison with previous year, there was a 34.7% increase in Vietnam publication in general and 41.6% increase in Vietnam universities' publication in WoS and Scopus database (Chung et al., 2019). Still, research ability of academics in Vietnam universities was inadequate (Nguyen and Klopper, 2019) and research productivity level remained low (Pham and Hayden, 2019).

Meanwhile, previous studies showed that active educational policies could promote scientific research and increased university faculty's research capacity. For example, Beerkens (2013) suggested that the effect of management practices on research productivity was consistently positive. According to that author, universities with an suitable management approach not only had higher absolute level of research productivity but also demonstrated faster growth in research productivity. Prendergast et al. (2019) found that communication policy such as enhanced peer mentoring program was effective in improving academic. On the other hand, institutional characteristics such as size, time in operation and location may also affect universities' academic performance, especially research productivity.

Although the literature abounds with evidence of effective policies and improvement of appropriate organizational characteristics promoting university research productivity in developed countries, little was done in developing countries like Vietnam. One of a few papers investigated institutional factors affecting university lecturers' research engagement was that of Tien et al. (2019) in which the author employed interpretive qualitative case study approach to examine situation in a higher education institution in the Mekong Delta region of Vietnam. They found that institutional factors affecting lecturers' research engagement in that university comprised of governmental policies, funding and structure, resources, teaching loads, leadership, and research

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[1] In Vietnam, according to Law on Higher education (2018), higher education institutions comprise of national and regional universities, universities, and other lawful university institutions. In this research, they are referred to as universities or higher education institutions.

https://doi.org/10.1016/j.heliyon.2021.e06024
Received 9 June 2020; Received in revised form 7 November 2020; Accepted 13 January 2021

environment. Moreover, previous studies in Vietnam tend to focus on social science universities in Vietnam such as that of Vuong et al. (2019) rather on science and technology universities.

In one of our previous studies (i.e., Nguyen and Nguyen, 2020), we explored the determinants of R&D outcomes in science and technology universities. However, as pointed out in the limitations section of that study, R&D outcomes were analysed merely based on faculty's evaluation and no objective measure of research productivity such as number of international publications was employed. Additionally, our previous research did not include variables reflecting organizational characteristics such as time in operation and location of the universities. Therefore, this current research was conducted to overcome these limitations. We believed that examining factors affecting research productivity at university level rather than from faculty staff level and with a more comprehensive set of variables would provide a richer and distinct insight.

This research seeks to contribute to the current literature in the following aspects. First, it was one of the first few studies examining research productivity at the university level of Vietnamese science and technology universities. Second, it examined the effect of institutional policies and organizational characteristics such as size, time in operation and location on university research productivity using an objective measure of university research productivity. Third, the research also examined the link between faculty research outcomes and research productivity at the university level as well as the direct/indirect impact of different variables on university research productivity. Finally, based on the findings, we proposed some policy recommendations to improve university research productivity.

The structure of this research article is as follows. The next section presents theoretical framework and research hypotheses. The third section presents research methodology and data. Research results are presented in the fourth section. The final section concludes the article and proposes several policy recommendations.

## 2. Theoretical framework and research hypotheses

### 2.1. Research productivity

There are several different viewpoints regarding university research productivity. Some authors such as Rivera-Huerta et al. (2011), Kim et al. (2019), Kosyakov and Guskov (2019) focused on the quantity aspects (i.e. research productivity was defined as number of publications or number of patents, etc.) while others such as Kaplan et al. (1997) or Daigle and Arnold (2000) emphasized the importance of research quality (i.e. how research outcomes changed the industry and society, the quality of journal in which the publications were published). Some researchers such as Sahoo et al. (2017) developed research productivity indicators. However, Nygaard and Bahgat (2018) argued that different bibliometric indicators captured different aspects of research performance, including diversity of output and collaboration, which simply reflected different publication practices. In this study, we focused on the quantity aspect of research productivity measured by international publication outcomes.

### 2.2. University's characteristics and its influence over research productivity

Many previous studies examined the relation between university's characteristics and research productivity. Based on these studies, 3 main characteristics were selected for our model, namely size, location, and time in operation.

#### 2.2.1. Size

Jordan et al. (1989) found that publishing activity was higher in private institutions and increased with department size at a diminishing rate. Golden and Carstensen (1992) also found that per capita publication increased, up to a point, with department size and is higher at private institutions. This is consistent with the findings of Meador et al. (1992). Gander (1995) used University of Utah data on funded research output to find that as faculty size increased research productivity rose. In another research, Schoenfeld et al. (2015) found that academic affiliation and number of fellows in a program was significantly associated with total number of publications. Similarly, Khan et al. (2017) found that number of fellows, faculty academic title, years in practice, and formal fellowship training had a significant positive correlation with both h-index and number of publications of medical university faculty. Thus, we proposed our first hypothesis:

H1: Higher institution of bigger size has higher research productivity than smaller ones.

#### 2.2.2. Time in operation and location

In Vietnam, universities located in big cities and have longer time in operation may have advantages in accumulating resources for research and thus have higher research productivity. The reason is that these universities may be more easily reached by talented students and high-skilled faculty concentrating in big cities. At the same time, universities in big cities may find it easier to collaborate with big companies locating in those cities. However, previous studies in other countries did not find evidence of this effect. For example, Chan et al. (2001) found that university history and tradition were irrelevant to university research productivity. Thus, we will test another two hypotheses:

H2: Higher institution having longer time in operation has higher research productivity than others.

H3: Higher institution located in big cities has higher research productivity than others.

### 2.3. Institutional policy

Nguyen et al. (2016) applied a qualitative approach to explore affordances, barriers, and motivations towards research engagement. The findings revealed that most of the respondents were aware of the importance of research, but their research productivity was low because of problems related to institutional factors including research financial support, teaching load, research collaboration, and research policy settings and practices. Institutional policy can be a decisive factors as it influences the time that faculty can spend on research. Smeltzer et al. (2016) examined research productivity of faculty teaching and mentoring doctoral students and found that the strongest predictor was the average number of hours spent on research-related activities, followed by time bought out from teaching and other responsibilities of the faculty role for research. In the following subsections, we will review various literature to form a base for our next hypotheses.

#### 2.3.1. Management policy

Management aspect of institutional policies is important for the success of research projects and helps improve quality of research outputs. Management decides the collaboration and sharing of research results as well as intra-university resource allocation. Proper resource allocation and effective cooperation can motivate researchers to implement their research projects and ultimately help improve research results at university level. For example, Uncles (2000) identified three research productivity impediments including inadequate training, sub-optimal concentrations of research activity, and competing commitments. These issues can be dealt with through formal research training and on-the-job practice, developing synergies between research and teaching/consulting, and finding partners to assist in fieldwork and analysis (Uncles, 2000).

Similarly, it is found that appropriate university management mechanisms can spur research and positively impact innovation performance (Chanthes, 2012). This can lead to an increase in the productivity of researchers on an individual level due to the positive incentives stemming from openness and efficiency in university governance (Beerkens, 2013). In other words, appropriate university management mechanisms can accelerate research process and participation of scientists in research

programs and eventually help increase research productivity at both the individual and university level. Therefore, in this study we propose the following hypotheses:

H4: University management policy has positive effect to faculty's research outcomes.

H5: University management policy has positive effect to university research productivity.

#### 2.3.2. Human resource policy

Carayol and Matt (2006) took account of individual and collective determinants to explain individual's productivity in terms of intensity and quality. According to their study, the intensity and quality of colleagues' research laboratory activities were beneficial for individual research. Nguyen (2016) investigated the extent to which leading universities motivated their academics to improve research performance and found that Vietnamese universities did not have enough powerful human resource policies to encourage academics to do research. Thus, in this research we examine the following 2 hypotheses:

H6: University human resource policy has positive effect to faculty's research outcomes.

H7: University human resource policy has positive effect to university research productivity.

#### 2.3.3. Communication policy

In terms of communication factor, Brodie (2000) suggested that organising annual conference and doctoral colloquium, establishing a journal that publishes high quality research, and establishing website as researchers' networking hub could increase academic research relevance and productivity. Vasileiadou and Vliegenthart (2009) found that communication exchange such as academic meetings was the most important predictor of research productivity. Besancenot et al. (2017) found evidence that size and quality of authors' networks were positively related to productivity. Ho et al. (2017) employed network theory to explore characteristics of a network of 412 Vietnamese distinguished social scientists. High clustering and low density were found to be tied to inefficient expertise dissemination among Vietnamese social scientists, and consequently to low scientific output. Similarly, Valsangkar et al. (2016) found that increased faculty participation in an academic association helped increase scientific impact and productivity among association members. Hafsteinsdóttir et al. (2017) found evidence of mentoring's influence on research productivity, career development and other outcomes of postdoctoral. On the other hand, Abramo et al. (2017) provided an in-depth analysis of the relation between the different types of collaboration and research productivity, showing how both were influenced by personal and organizational variables but only intramural and domestic level collaboration had a positive effect on research productivity. On the contrary, Nguyen et al. (2017) found that the vast majority of scientific papers from Vietnam was attributable to international collaboration. As empirical evidence for this factor was inconclusive, we examine the following 2 hypotheses:

H8: University communication policy has positive effect to faculty's research outcomes.

H9: University communication policy has positive effect to university research productivity.

#### 2.3.4. Infrastructure policy

Alrahlah (2016) performed a qualitative study on a group of 21 respondents working in different dental colleges and identified a lack of adequate research facilities as barriers to their research productivity. Similarly, according to Kang et al. (2017), infrastructure aspect such as indoor environmental quality had significant impacts on university faculty's research productivity. Therefore, we examine the following 2 hypotheses:

H10: University infrastructure policy has positive effect to faculty's research outcomes.

H11: University infrastructure policy has positive effect to university research productivity.

### 2.4. Financial constraints

Impact of financial factors on research productivity was found in various studies. For example, Jacob and Lefgren (2011) estimated a significant impact of receiving a research grant on subsequent publications and citations. Zhang et al. (2017) also found that receipt of government funding was associated with a higher h-index. Similarly, Hottenrott and Lawson (2017) found that research grants were generally associated with higher research outcomes. Zaorsky et al. (2019) found an association between disclosed payment from the industry and increased individual research productivity metrics. Pitt et al. (2017) found that the combination of increased awareness of peers' academic productivity and a weighted lottery financial incentive appeared to be a useful model for stimulating academic productivity in early-career faculty.

Therefore, we examine the following 2 hypotheses:

H12: Financial constraint has negative effect to faculty's research outcomes.

H13: Financial constraint has negative effect university research productivity.

In this study, we defined financial constraint as the hinders that universities researchers must face while finding financial resources for their own research. On the other hand, infrastructure policy is the university investment on infrastructure which may affect both research and training and both university and individual's level.

### 2.5. Faculty's individual ability constraint

Individual ability was found to be an important factor affecting research productivity in many previous studies. Huang et al. (2015) found that research productivity increased with departmental academic rank. Shih et al. (2018) affirmed that factors associated with increased academic productivity include attaining higher academic positions, having a longer career length, having greater numbers of research grants, and having MD and PhD degrees. Rubin and Callaghan (2019) found that individuals with higher self-reported levels of entrepreneurial orientation and more eager to apply novel technological research methods have higher levels of research productivity. Jean and Felbaum (2019) identified a positive correlation between the subjects' academic productivity and the ranking of all the institutions throughout their education, training, and current employment. Therefore, we examine the following 2 hypotheses:

H14: Faculty's individual ability constraint has negative effect to faculty's research outcomes.

H15: Faculty's individual ability constraint has negative effect to university research productivity.

H16: Faculty research outcomes has a positive impact on research productivity.

We combined all research hypotheses in our research model as depicted in Figure 1.

## 3. Research methodology

### 3.1. Measurement scales

Measurement constructs reflecting institutional policies used in our research model were developed based on research of Nguyen and Nguyen (2020). Specifically, infrastructure policy was measured by 5 items, management policy was measured by 7 items, human resource policy was measured by 5 items, communication policy was measured by 4 items, financial constraint was measured by 4 items, faculty's individual ability constraint was measured by 9 items, faculty research outcomes was measured by 4 items. These items were measured using questions by the Likert scale with 1 being totally disagree and 5 being

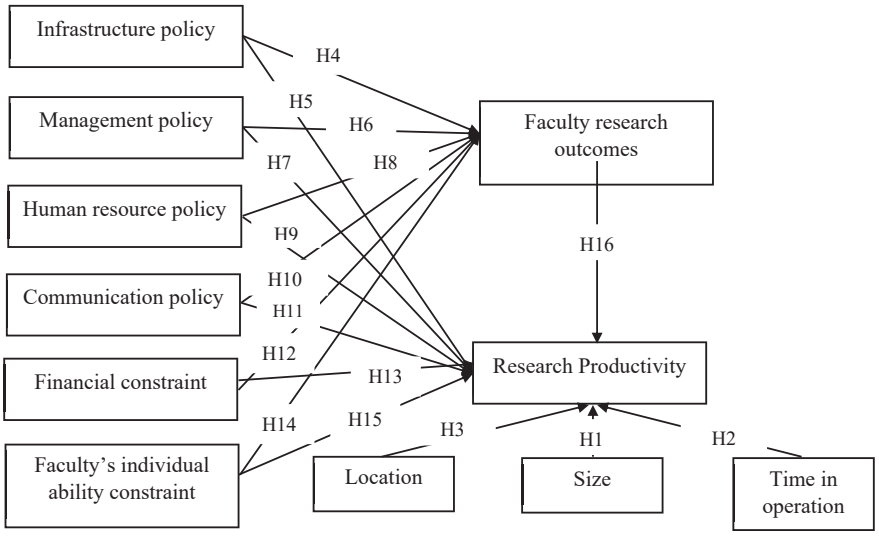



**Figure 1.** Research model (Source: Author's compilation).

totally agree. For example, to measure communication policy, the respondents were asked 4 questions whether they agree or disagree with the following statements (1) Your university maintains good professional network (2) Your university establishes frequent intra-organization academic communication (3) Your university help researchers connect to external sources for R&D activities (4) Your university sufficiently organizes R&D workshops/symposium/conferences. The items for measurement scales are described in appendix A. Appendix B presents summary statistics of items in measurement constructs.

### 3.2. Data

Main data were collected through questionnaire survey conducted by Association of Vietnam University and Colleges in Vietnam science and technology universities in corporation with Hanoi University of Science and Technology under research project BKA-2017-41 funded by Ministry of Education and Training, Vietnam.

Before the research project was carried out, our research proposal including ethical issues was approved by a committee from Ministry of Education and Training, Vietnam specially designated for research project BKA-2017-41 in 2016. We included informed consent in our questionnaire. The participants had the right to refuse to fill in the questionnaire after reading it. In other words, informed consent was obtained from all participants in our research.

The questionnaires were distributed by hand to the participants of the National Conference on University autonomy and by mail sent to the target university representatives. At least one representative from the 115 targeted universities sent back a valid questionnaire answer. 585 questionnaire forms were sent to universities in which 468 completed forms were sent back. The number of valid answers was 415.

Data about number of student intakes, time in operation and university location was collected from Vietnam Ministry of Education and Training. Data for international publication of the universities were obtained from Scopus database for the year from June 2017 to June 2018. Among 115 targeted universities, 33 universities were private universities, 31 universities were under control of Ministry of Education and Training, the rest was under control of other ministries or provincial governments. The average international publication of the universities was 44. The annual university student intakes ranged from 100 to 7340 with mean value of 2270. The years in operation of the universities under survey ranged from 4 to 117.

### 3.3. Data analysis method

Multivariate data analysis method was used to analyse surveyed data and test proposed hypotheses with structural equation modelling. The reliability of each construct in the model and internal consistency were evaluated by Cronbach's Alpha coefficient value and exploratory factor analysis. We used confirmatory factor analysis method with data conversion to check for construct validity together with common method bias and non-response bias tests.

Because the survey was conducted at individual level (i.e., information was collected from university representatives) while the aim of the study was to evaluate the effect of policies and characteristics on research productivity at the university level, we transformed the data from individual level into university level by the following formula:

$$x_i = \frac{1}{n}\sum_{1}^{n} x_{ij} \quad (1)$$

In which: $x_i$ is the value of item $i^{th}$ in the construct at university level.

$x_{ij}$ is the value of the item at university i
n is the number of respondents in university i.

Number of student intake (size), number of scientific papers published in Scopus index (research productivity) and time in operation vary greatly among the surveyed universities. Therefore, we used natural logarithm of each variable to reduce heterogeneity in the estimation.

As mentioned earlier, this research was extended from one of our previous study (Nguyen and Nguyen, 2020). For comparability purpose, we applied a similar analytical method. However, there were some significant differences between the methods being applied in the 2 models. In the research model of our previous paper, we applied individual approach (i.e., from faculty's perspective). Thus, we had 415 observations representing opinions of 415 faculty researchers. However, in the research model of this article, we applied institutional approach and aggregated the opinions of faculty of the same university and transformed the data from individual level into university level using Eq. (1). Thus, we had only 115 observations representing 115 universities in the model.

In addition, in this study, we focused on the determinants of various factors on university research productivity which was proxied by total number of international publications. This was different from our

previous research (Nguyen and Nguyen, 2020) in which the dependent variable was faculty research outcomes. In this research, faculty's own evaluation about their research outcomes was used as an intermediary variable which also affected university research productivity. Direct and indirect impact of various variables on university research productivity were also examined in this research.

## 4. Research results

### 4.1. Reliability and validity

The analysis results indicated that all constructs in the model reached satisfied reliability conditions. Specifically, Cronbach's alpha coefficients were all larger than 0.7; KMO was larger than 0.5 with p-value $< 0.05$. Total variance explained was 64% which was much higher than the threshold level of 50%. Factor loadings of each items in the constructs were greater than 0.5 (Table 1). The findings of confirmatory factor analysis showed that our research model fit the actual data, specifically Chi – square/df = 1.578 was less than 3, CFI = 0.914, TLI = 0.903, IFI = 0.915 were all greater than 0.9, and RMSEA = 0.071 was less than 0.08 (Table 1). The factor loadings of each item in the constructs were greater than 0.5 showing that the constructs in the model reached convergent validity (Hair et al., 2018). The composite reliability coefficients were greater than 0.7 and average variance extracted was greater than 50% indicating that the model constructs were reliable.

The value of the square root of AVEs was greater than any correlation coefficients in the model which showed that the constructs reached discriminant validity (Table 2).

### 4.2. Common method bias and non-response bias

Because common method bias may influence the true relationship between constructs (Podsakoff et al., 2003), we designed the constructs to avoid ambiguous items and control for acquiescence and dis-acquiescence biases. Harman test results indicated that when fixed to a unique factor of all items, the total variance explained was 24.868% which was much smaller than 50%. This meaned that common method bias did not affect our study results.

To examine non-response bias, we used t-test to compare early respondents and late respondents divided at a ratio of 70:30 (Armstrong and Overton, 2018). The findings found no difference between the two groups implying that non-response bias was not a concern in our research.

### 4.3. Hypothesis testing

We used structural equation modelling to test our research hypotheses. The results showed that our model fit with actual data: Chi – square/df = 1.671 was less than 3; CFI = 0.905, IFI = 0.907 were all greater than 0.9, and RMSEA = 0.077 was less than 0.08. The estimation results were shown in Figure 2.

Estimation results with standardized coefficients indicated that eight hypotheses were accepted, including: (H1) Size of university is positively associated with research productivity ($\beta = 0.34$, p-value $< 0.05$); (H2) Time in operation of university is positively associated with research productivity ($\beta = 0.23$, p-value $< 0.05$); (H3) Location (in a big city) is positively associated with research productivity ($\beta = 0.13$, p-value $< 0.05$); (H5) Management policy has a positive impact on research productivity ($\beta = 0.35$, p-value $< 0.05$); (H6) Human resource policy has a positive impact on faculty research outcomes ($\beta = 0.21$, p-value $< 0.05$); (H11) Infrastructure policy has a positive impact on research productivity ($\beta = 0.34$, p-value $< 0.05$); (H16) Faculty research outcomes has a positive impact on research productivity ($\beta = 0.15$, p-value $< 0.05$); (H8) Communication policy has a negative impact on faculty research outcomes ($\beta = -0.21$, p-value $< 0.05$). Other hypotheses in the model were rejected. In other words, the results supported hypotheses H1, H2, H3, H5, H6, H11, H16 and rejected hypotheses H4, H7, H9, H10, H12, H13, H14 and H15 (Figure 2). We found an unexpected relationship contrary to hypothesis H8. To assess the effect of each construct on the research productivity of university we used total effect coefficient. The findings showed that the largest effect was MAN ($\gamma = 0.349$), and smallest was HUM ($\gamma = 0.029$) (Table 3).

## 5. Conclusions and policy recommendations

### 5.1. Summary of key findings

The research results helped answer our research questions about the impact of institutional policies and university characteristics on university research results and research productivity. The study also verified the influence mechanism of research development support policies and university characteristics on faculty research results and research productivity at institutional level. In general, the results were consistent with previous studies (Akl et al., 2012). However, there were certain differences stemming from the context and specific characteristics of Vietnamese universities.

The study detected a significant impact of university characteristics on university research productivity. Specifically, university size proxied by the number of enrolments had a strong influence on universities' research productivity ($\beta = 0.34$). Time in operation also affected research productivity ($\beta = 0.23$). The authors also found a significant but relatively weaker influence of location ($\beta = 0.16$) on university research productivity.

These results were quite consistent with previous studies showing that the university's published scientific output was influenced by organizational characteristics such as size, location and years in operation (Schoenfeld et al., 2015). The results supported the argument that a larger university would have more faculty and researchers involved in research activities and consequently lead to a greater number of scientific

**Table 1.** Results of EFA and CFA analysis.

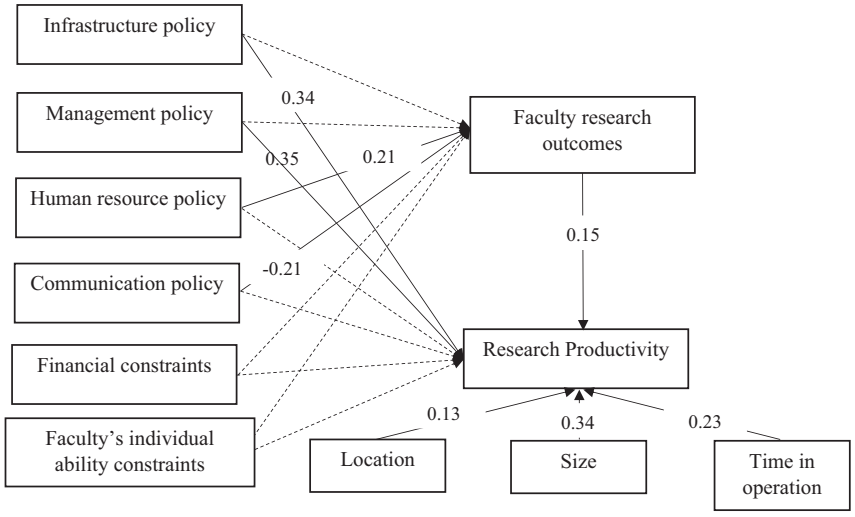
| Constructs | N of Items | EFA | | CFA | | |
|---|---|---|---|---|---|---|
| | | KMO = 0.865 p-value = 0.000; TVE = 64% | | Chi-square/df = 1.578, CFI = 0.914, TLI = 0.903, IFI = 0.915. RMSEA = 0.071 | | |
| | | Factor loadings range | Cronbach's Alpha | Composite reliability | AVE | Factor loadings range |
| INF | 5 | 0.648–0.893 | 0.979 | 0.855 | 66.80% | 0.661–0.957 |
| MAN | 7 | 0.682–0.725 | 0.869 | 0.905 | 58.36% | 0.595–0.945 |
| HUM | 5 | 0.731–0.870 | 0.865 | 0.924 | 71.21% | 0.837–0.929 |
| COM | 4 | 0.989–0.959 | 0.939 | 0.951 | 83.02% | 0.832–0.927 |
| FIN | 4 | 0.712–0.859 | 0.765 | 0.836 | 63.58% | 0.766–0.943 |
| IND | 9 | 0.679–0.842 | 0.823 | 0.909 | 66.99% | 0.787–0.924 |
| OUT | 4 | 0.806–0.929 | 0.853 | 0.905 | 70.72% | 0.761–0.983 |

Source: Author's calculation

**Table 2.** Discriminant validity of model constructs.

| Constructs | INF | MAN | HUM | COM | FIN | IND | OUT |
|---|---|---|---|---|---|---|---|
| INF | **0.817** | | | | | | |
| MAN | 0.511 | **0.764** | | | | | |
| HUM | 0.666 | 0.636 | **0.844** | | | | |
| COM | 0.007 | 0.122 | 0.011 | **0.911** | | | |
| FIN | 0.327 | 0.124 | 0.128 | -0.022 | **0.797** | | |
| IND | -0.339 | -0.605 | -0.477 | -0.232 | -0.054 | **0.819** | |
| OUT | 0.200 | 0.124 | 0.200 | -0.210 | 0.142 | -0.063 | **0.819** |

Notes: Diagonal elements (in bold) showed the square roots of AVEs.
Source: Author's calculation




Chi-square/df = 1.671, CFI = 0.905, TLI = 0.893, IFI = 0.907, RMSEA = 0.077

Notes: ——→ Statistical significance - - - - - - - - - → Statistical insignificance

*Location (1= located in big cities, 0 = otherwise), size = natural logarithm of number of university student recruitment; time in operation = natural logarithm of time in operation of universities, research productivity = natural logarithm of number of papers published in Scopus indexed journals.*

**Figure 2.** Relationships between research model constructs (Source: Author's calculation).

**Table 3.** Direct, indirect, and total effect coefficients of each construct on research productivity.

| Dependent variables | Effect | Location | Time | Size | COM | HUM | MAN | CS | OUT |
|---|---|---|---|---|---|---|---|---|---|
| OUT | Total | 0.000 | 0.000 | 0.000 | -0.209 | 0.192 | 0.000 | 0.000 | 0.000 |
| | Direct | 0.000 | 0.000 | 0.000 | -0.209 | 0.192 | 0.000 | 0.000 | 0.000 |
| | Indirect | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| Research productivity | Total | 0.129 | 0.246 | 0.339 | -0.032 | 0.029 | 0.349 | 0.334 | 0.152 |
| | Direct | 0.129 | 0.246 | 0.339 | 0.000 | 0.000 | 0.349 | 0.334 | 0.152 |
| | Indirect | 0.000 | 0.000 | 0.000 | -0.032 | 0.029 | 0.000 | 0.000 | 0.000 |

Source: Author's calculation

publications. Favourable locations helped the universities attract better students and better faculty and researchers. This explained why the most productive Vietnam universities in terms of scientific publication locate in Hanoi and Ho Chi Minh City, the two biggest cities in Vietnam. Number of years in operation also reflected the school's viability and growth through different stages. Older universities had more advantages in terms of history and fame than younger universities. However, at present, young universities in Vietnam are determinedly building up their reputation, making it difficult for old universities to maintain these advantages in the long run. These results have implications for both old and new universities in choosing their targeted size, campus location and brand name development. These strategic decisions will decide their positions in the university rankings in the long term.

Survey data also confirmed a significant and positive link between faculty research outcomes and research productivity at the university level. We also found evidence that university's science development policies influenced university's research results and research productivity. Specifically, we found positive impact of human resource

development policy on research outcomes at the faculty level. This implied that human resource development policies such as attracting talented and active faculty were crucial to develop faculty research activities and indirectly increase university research productivity. This result was supported by previous studies in which university human resource development had a positive impact on research activities at both individual and institutional level (Carayol and Matt, 2006; Nguyen, 2016).

In terms of communication policies, contrary to our expectation, this factor had a direct negative impact on faculty research outcomes and therefore had a negative impact on university research productivity. This needs to be explained in the context of this study. The research productivity in this research was judged based on the number of articles published in the Scopus database and did not consider the articles published in domestic journals. Therefore, research productivity here was only evaluated according to international standards and thus could be overlooked in other scientific activities. Another fact that should be taken into consideration was that the request for scientific funding from scientific funds in Vietnam did not require international publication until recently. For example, the requirements for research project funding of Ministry of Science and Technology before 2018 did not list international publication as mandatory requirement. Therefore, there was a tendency for researchers to publish in domestic journals to speed up scientific funding. This may be the reason for the increased level of interpersonal engagement for research projects that did not promote international publication where project managers tend to opt for more domestic journals instead of international journals. Consequently, improvement in communication policies did not help increase research productivity according to international standards.

We also found positive direct effects of management policies and infrastructure development policies on university research productivity. Data analysis showed that for science and technology universities, policies for large capital investment or research activity support such as laboratory construction, experiment equipment installation significantly affected the research capacity of university lecturers and researchers. This result reinforced the arguments from previous studies that developing research, especially research in the fields of science and technology, required large investments in research infrastructure (Alrahlah, 2016; Kang et al., 2017). The logic of creating high research productivity was to invest in the necessary conditions for research activities (i.e., infrastructure) and to put in place an incentive-based management mechanism encouraging research activities.

In comparison with our previous study (Nguyen and Nguyen, 2020), there are some different results which reflected the differences between faculty's perspective approach and the institutional level approach. Firstly, our previous study showed that financial factors were one of the two variables that significantly affected faculty's research outcomes. However, in this research, it was shown that management factor rather than financial factor significantly affect research productivity at university level. It may be because faculty tended to overemphasize financial factor as their activities can be directly and individually hindered by financial constraints. The authors believed that financial support affected research motivation especially from faculty's perspective. However, if financial support was too small to influence the research efforts of university faculty members, it may not affect their research or non-research decisions. This may be especially true if it comes to international standard research such as Scopus journal publication which requires lots of time and efforts. The fact that the financial support for research activities at Vietnamese universities was still modest may be the reason for the negligible impact of financial support on university research productivity at institutional level.

Secondly, in this study, human resource policy had significant indirect impact on university research productivity at institutional level while this variable did not significantly affect faculty research outcomes in our previous study. This showed that examining factors affecting research productivity at individual and university levels generated different pictures. Because there was a strong connection between faculty's research outcomes based on their own evaluation and university research productivity, if the universities want to quickly boost the number of international publications, they should focus on infrastructure and management policies but at the same time should not neglect human resource.

Lastly, it is worth noting that while size of the university had no significant impact on faculty research outcomes in our previous research, this current study showed significant impacts of this variable and other institutional characteristics variables on university research productivity. This might be explained by the fact that university size and fame tended to be overlooked by faculty when subjectively evaluating their individual research outcomes. However, these variable and other institutional characteristics should not be left aside when examining research productivity at university level.

### 5.2. Implications for policy

Based on the above-mentioned research results, we proposed some suggestions for improving university research productivity.

Firstly, scientific funding management mechanism needs to be vigorously revised in direction of simplifying the process of reviewing and approving research grants, reducing administrative procedures, and increasing commitments in terms of international publications outputs.

Secondly, universities should be encouraged to invest in building infrastructure for research and training activities, attracting good researchers to work at the university, forming strong research project teams towards increase research productivity. Universities should consider investing in infrastructure and developing human resources for research as a priority to increase research productivity and improve universities' position in academic rankings. Universities need to strengthen their linkages with enterprises and attract financial sources from enterprises in forms of scientific grants, reducing the dependence on government research funds.

Thirdly, the location of new university campuses should be carefully assessed so that the university can attract students to generate financial sources for the universities' activities and promote scientific research. New campuses should be located near economic centres and large cities to attract lecturers and learners.

Fourth, universities should consider policies that motivate their academics in both teaching and researching, helping them to break out of their ability constraint.

### 5.3. Research limitations and implications for future research

This research contains some inherent limitations. First, due to its design, the research could not examine faculty characteristics which might affect research productivity such as gender, age, degree, rank as mentioned by Paik et al. (2014), Vuong et al. (2017), Adib et al. (2018) or discipline and years of work experience as mentioned by Shih et al. (2018), Nafukho et al. (2019) and Mueller et al. (2016). Examining these characteristics might solve the unanswered questions in our research such as why older universities have more advantages in terms of history and fame than younger universities. Second, the research used international publication in Scopus database as a simple measure of research productivity. This measure might not reflect all research productivity aspects. Third, another important limitation of the research was that the variables measuring institutional policies were based on the opinions of university representatives, rather than on objective data. Therefore, one person's view on, for example, "sufficient faculty members", might not be the same, even if they were at the same university. Last, the data just covered science and technology universities which accounted for about one third of all universities in Vietnam. Future research should seek remedies for these limitations to depict a more complete image of factors affecting research productivity in Vietnam.

## Declarations

### Author contribution statement

T.D. Nguyen, N.D. Nguyen and D.T. Kien: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

### Funding statement

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

### Data availability statement

Data will be made available on request.

### Declaration of interests statement

The authors declare no conflict of interest.

### Additional information

Supplementary content related to this article has been published online at https://doi.org/10.1016/j.heliyon.2021.e06024.

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