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Scientists' motivation to patent and commercialize their inventions at universities and research institutes

Huu Can Nguyen*

Vietnam Intellectual Property Research Institute

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Abstract:

Self-determination theory (SDT) and a literature review suggests that scientists' motivation to patent and commercialize their inventions is effort expended by a variety of intrinsic and extrinsic reasons. Based on qualitative analysis results, we found explorative evidence that both intrinsic reasons belonging to the scientists themselves and extrinsic ones arising from the environment of the scientists' inventive activities are positively associated with the scientists' motivation. Therefore, to implement the Intellectual Property Strategy to 2030, policymakers need to consider a variety of factors including not only extrinsic rewards, but also personal and social aspects related to intrinsic desires.

Keywords: **commercialize, motivation, patent, scientist, self-determination.**

Classification number: ***7***

Introduction

Universities and research institutes (hereinafter referred to as "academic organizations") are considered to have a key role in creating and developing knowledge for society [1]. Patent protection, the fruit of innovative and inventive activities, is regarded as an important factor in promoting technology transfer from academic organizations to private sectors and industry [2], as well as innovative start-ups [3]. For academic organizations, one of the most important goals of patenting and commercializing scientists' inventions is to encourage inventive activity and to recoup investment costs for reinvesting in research and development [4]. Thereby more inventions are created, while technology dissemination is promoted, and inventions increasingly contribute more positively to economic growth in many countries and regions around the world [5]. In Vietnam, according to D.D. Luong and D.T. Dien (2017) [6], the total value of patent licensing of Ho Chi Minh city University of Technology alone was over 90 billion VND in 2012. The revenue from transferring research outputs of regional universities such as Bach Khoa, Da Nang, etc., to production facilities in the Central, Central Highlands, and Mekong river delta is about 20 billion VND/year, which contributes to bringing a great source of revenue for those academic organizations as well as local economic growth.

In general, scientists in academic organizations carry out the tasks of education, research, and development. Despite their importance as inventors, the scientists' motivations and inventive activities have been relatively neglected study topics. There have been a few studies that focus on the roles of individual inventors in the academic organizations and explore why academic scientists file patent applications and commercialize their patents. In Vietnam, there is little literature on

*Email: nhatviet00@gmail.com

this topic and that demands more clarification of the reasons for the motivation to patent and commercialize scientists' inventions to implement the Intellectual Property Strategy to 2030.

Self-determination theory framework

SDT introduced by E.L. Deci and R.M. Ryan (2000) [7], R.M. Ryan and E.L. Deci (2000) [8], M. Gagne and E.L. Deci (2005) [9] provides some useful insights on the multidimensional nature of human motivation, especially within the framework of inventive activities and intellectual property. In this theory, motivation is considered as the outcome of the interaction between external regulatory processes and individual internal psychological needs for autonomy. It is supposed that scientists are motivated to act when believing that the activity will lead to desired results; the theory not only differentiates the content of outcomes and regulatory processes but also places emphasis on self-determination behaviour in the motivational process, which is particularly commensurate with scientists who enjoy considerable self-control in their work. In SDT, there are three main states: intrinsic motivation, which refers to doing something for its inherent joy or satisfaction; extrinsic motivation, which refers to doing something for a separable outcome or external reward; and finally, amotivation, which means not having any intention to act because of lacking interest in the activity [10]. Based on these concepts, SDT suggests that a scientist's motivation can range from amotivation, which is wholly lacking in autonomy to intrinsic motivation, which is a typical self-determined behaviour stemming from an individual's spontaneous interest rather than driven by external reasons. The degree of self-determination in the extrinsic motivation can range from fully externally regulated behaviour to a fully internally integrated one which approximates the intrinsic motivation. Based on SDT, T.M. Amabile, et al. (1994) [11] argued that some highly self-determined individuals (e.g., creative scientists) may be both strongly intrinsically interested in the activity and extrinsically motivated to acquire rewards such as prestige, promotion, and salary for that activity.

Reasons for patenting and commercializing scientists' inventions

Patenting is theoretically considered as a mechanism to privatize technical information by excluding others to acquire monopoly rights to commercially use the inventions. Scholars around the world have identified various reasons to file patent applications in academic organizations. In this paper, the analysis of reasons for patenting and commercializing scientists' inventions builds on theories of motivation in social psychology, namely, SDT. Based on these theories, the above-mentioned reasons include intrinsic and extrinsic factors affecting the motivation in which intrinsic ones have long been recognized by scholars as a pervasive and powerful driver of scientists' motivation (Fig. 1). Firstly, these studies suggest that scientists have the desire to expend their effort to benefit others and their community during their activities, which is regarded as *prosocial* reasons, a specific form of intrinsic factors [12]. Moreover, S. Lindenberg (2001) [13] suggested that *having fun or the joy of achievement* is the other important enjoyment-based intrinsic reason. This reason underpinning inventive behaviour is a longstanding idea [14, 15]. Creative scientists are motivated to get their patents because of puzzle-solving nature of patented inventions, i.e., the scientists have successfully "solved the long-existed challenging technical problems", that make them satisfied. In addition to those intrinsic reasons, the prevention of imitation, blocking, securing the freedom to operate, signalling and generating licensing opportunities are considered

as the most important extrinsic reasons [16, 17]. One of the most prevalent reasons for filing patent applications is the *prevention of imitation of inventions* [18], which is the reason for the existence of the patent system because patents reward inventors for disclosing the invention with the exclusive legal right to exclude others from using it [19, 20]. Using patents to "block competitors", or patent fencing, is another important reason for patenting. Scientists often seek patents for their inventions that may not be incorporated into their products or processes, and such patents can be used as tools to prevent competitors from exploiting substitute technologies [21, 22]. The other reason for filing patent applications is to secure 'freedom to operate' [23], which is defined as the right to exploit the invention in advance [24]. Since patent applications are published 18 months after the filing date, publication makes the applied invention prior art and prevents any third party from patenting the same invention and reduces the risk of being excluded by third parties from using their own inventions [25]. Sending signals to investors, potential cooperative partners, and customers is another use of patenting. Since patents contain important technical information on inventions, they inform the public about the technological quality and the inventive step of the inventions, and premium profits might be attainable as the patents offer the possibility to build an economic monopoly. *Generating revenues from licensing* is a final reason for patenting [26]. Out-licensing can be a profitable option for academic organizations due to their lack of the demanded resources and supplementary assets required to manufacture and sell products based on new inventions [27]. Licensing is also attractive for academic organizations whose core activities are research and development rather than manufacturing or production.

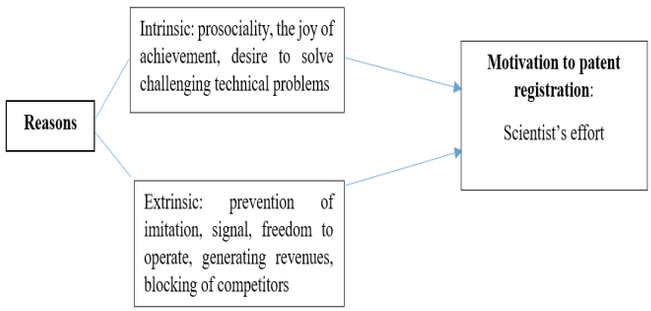

Fig. 1. Reasons for scientists' motivation to patenting.

Due to the tasks of academic scientists, the important mechanism in which their technologies contribute to economic growth is mainly by transforming patented inventions into innovation through licensing their research outputs. In this paper, our discussion on commercializing patents is focused on licensing activity, including spin-offs, because this relates directly to the transfer of technical knowledge for commercial use. In their commercial pursuits, scientists may be motivated by a variety of intrinsic and extrinsic reasons (Fig. 2). Firstly, B.T. Eiduson (1962) [28] and S. Cotgrove (1970) [29] suggested that *the desire to engage in solving challenging technical problems* is the hallmark of a dedicated scientist who is intrinsically motivated to solve long existing technical problems and who derives joyful satisfaction from engaging in solving challenges and inventive activities. This view suggests that the reason why a scientist's pursuit of creativity and knowledge could take place in the context of technology application and the exploitation of patented inventions. Some extrinsic reasons for scientists' motivation to commercialize their inventions are *the recognition and prestige* bestowed by their professional peers and other rewards such as promotion and salary, which usually originate from the degree of recognition achieved [30, 31]. J. Owen-Smith (2003) [32] pointed out that academic organizations can use patents as an alternative tool for obtaining more invested resources beyond traditional rewards. Some scientists are prompted to use commercial

activities as a means to further their academic careers because of the increasing reputational returns associated with commercialization success [33]. In addition to personal pecuniary gain, L. Alice (2011) [34] argued that scientists have opportunities to reap financial rewards from commercial activities based on the existence of an entrepreneurial context. Scholars have agreed that access to financial resources, i.e., research funding, is also critical for scientists and this need is another extrinsic reason for scientists' motivation to commercialize their inventions, e.g., during the course of seeking more resources for continued research that convert early stage inventions into marketable products or processes.

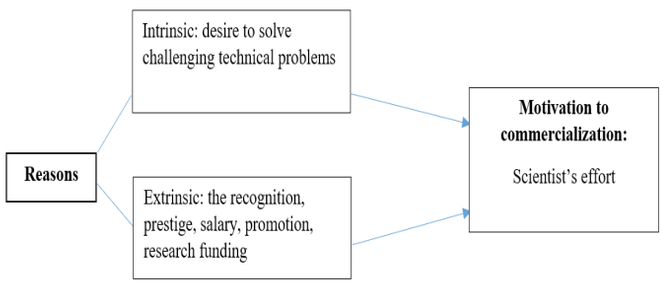

Fig. 2. Reasons for scientists' motivation to commercializing patents.

Intrinsic and extrinsic motivation for patenting and commercializing patented inventions can co-exist and motivate scientists to different degrees in their effort to file patent applications and commercialize their patented inventions. In the context of academic organizations, scientists can choose whether to engage with filing patent applications or commercializing their patents according to the degree of autonomy and their beliefs about the potential values and benefits of such activities. Therefore, these engagements can be either autonomous or controlled activities depending on how far scientists have internalized values associated with them. The process in which scientists identify with the behaviour for their self-selected values is similar to the identification process mentioned in SDT [8] and may be activated by intrinsic and extrinsic motivation in patenting and commercializing patented inventions.

Based on SDT, some researchers in the field of creativity, motivation, and inventive activities, e.g., A.M. Grant and J.W. Berry (2011) [35], defined motivation as the desire to expend effort based on interest of the activity itself or outcomes external to the activity, such as recognition, welfare of other people, or rewards. Therefore, in this article, the scientists' motivation is measured finally by their effort. In the context of both academic and entrepreneurial studies, A.M. Grant (2008) [12] suggested that scientists, like other professionals, have the desire to expend effort to benefit others and community. Within the motivation mechanism, scientists' desires play a role as reasons that stimulate and sustain effort made by scientists, and that effort denotes their motivation.

Some insights on Vietnamese scientists' motivation in academic organizations

In this paper, the qualitative method is applied to explore reasons affecting scientists' motivation in patenting and commercializing their inventions in academic organizations. In particular, the author conducted in-depth interviews based on questions designed to explore the experiences of these scientists. Among those questions, the question "what are reasons for encouraging the scientist to file a patent application?" and "what are reasons for encouraging the scientist to commercialize his/her invention?" are the most important open-ended questions. The in-depth interviews include five researchers specializing in research and/or management in the field of patents at large academic organizations such as the Foreign Trade University, Vietnam National University, Hanoi, the Department of Science and Technology of Thua

Thien Hue, Vietnam National University, Ho Chi Minh city, and the National Institute of Patent and Technology Exploitation. According to the results of the qualitative analysis, in Vietnam, the reasons that directly influence the motivation to patent and commercialize scientists' inventions in academic organizations are also divided into intrinsic and extrinsic groups as suggested by R.M. Ryan (1995) [10]. While the intrinsic reasons belong to the scientists themselves, such as prosociality, the joy of achievement, desire to solve challenging technical problems, or extrinsic reasons arising from the environment for scientists' inventive activities such as prevention of imitation, signalling, freedom to operate, generating revenues, blocking competitors from patenting, and rewards like recognition, prestige, salary, promotion, or research funding (for commercializing). This result is also consistent with the SDT theory introduced by E.L. Deci and R.M. Ryan (2000) [7], R.M. Ryan, E.L. Deci (2000) [8], and M. Gagne and E.L. Deci (2005) [9] in which intrinsic reasons such as desire to engage in solving challenging technical problems has long been recognized by these scholars as a powerful driver of scientists' motivation. A mix of these reasons play a very important role in encouraging scientists to file patent applications and commercialize their patented inventions. Of these reasons, extrinsic reasons seem to play a more important role than intrinsic reasons, especially "generating revenues" for patenting and "research funding" for commercializing. These findings are similar to the argument of T.M. Amabile, et al. (1994) [11] that highly self-determined scientists may be extrinsically motivated to acquire rewards such as pecuniary or financial incentives for their patents. The reply of a researcher from the Foreign Trade University to the question of what drove scientists to file patent applications is illustrative: "... researchers are less interested in filing patent applications because they think the invention is not in their possession. Even if a researcher can apply for patent protection and is able to receive remuneration from exploiting the invention, the possibility of such remuneration is not clear... many researchers are sceptical about their rights and their own interests...". It is inferred that, for scientists, the lack of financial resources such as revenue generated from inventions, salary, research funding, etc., seems to be a factor hindering the motivation to apply for patents. The following quote by a researcher of Vietnam National University, Hanoi is indicative: "Inventions which are created with the fundings of the academic organizations personally registered by the scientist who is the inventor and individually commercialized by him or her. It is very difficult for the organizations to control this undue situation. The rights and responsibilities of scientists for inventions created by the state budget or organizations' fundings have not been clearly and adequately defined".

Our evidence based on these deep interviews also suggests that prosociality, which is a very important reason for patenting, may affect the extent to which patented inventions are commercialized and improve the university-industry collaboration of inventive and innovative activities. The majority of those interviewed believed in positive social benefits of the patented inventions based on a desire to help others and this prosocial behaviour can make the relationship between academic organizations and industrial enterprises closer and as an extension of the inventive activities. Without this factor, the patenting seems to be hindered because of lacking customer and market satisfaction. The following quote by a manager of the Department of Science and Technology of Thua Thien Hue is suggestive: *"Due to the fact that the research outputs are not applicable and not commercially viable, so the scientist in charge of registering patents is not interested in filing*

patent applications for these results". To these scientists, patent commercialization represents a kind of technical solving activity that benefit a community or society. The following interview quote vividly expresses this issue experienced by a manager of Vietnam National University, Ho Chi Minh city: "There should be a mechanism to allow universities and research institutes to hire a third party specializing in negotiating and licensing inventions to enterprises in order to enhance commercialization activities. There is the fact that scientists generate their inventions but enterprises do not need them and adversely, technical solutions that enterprises need cannot reach those scientists".

In the specific context in Vietnamese academic organizations, based on a sample of 153 scientists working at the Vietnam Academy of Science and Technology (VAST), V.T. Nguyen, et al. (2018) [36] finds that international publications are determined as the result of research funding, which have become more attractive to scientists regarding both financial and reputation perspectives. These findings are similar to comments of a researcher of the National Institute of Patent and Technology Exploitation: "... the reason for limiting the number of patent applications at research institutes, universities... that it is easier to publish international articles than to have inventions patented... the fundings for publishing international articles is much more... the time to complete the article is faster... the international articles are given priority in considering the scientists' academic rank over the inventions". These findings suggest that the recognition, prestige, and promotion, which are extrinsic reasons not only associated with the scientists' motivation to commercialize their inventions but also to patenting. Based on a survey that was conducted using stratified random sampling from 255 scientists from academic organizations, and the structural equation modelling was employed to estimate the correlations. D.C. Doanh, et al. (2021) [37] argued that regulatory support, such as government assistance for scientists with commercializing their inventions, was not found to have a direct role in shaping intention to commercialize the scientists' inventions.

Discussion and implications for practice

Inventions and patented technologies have recently been a more important contributing factor of economic growth in Vietnam. However, statistics showed that the number of patent applications from universities reached its highest level of about 160 applications, with about 110 applications from research institutes (in the year 2020). This number is still much lower than that of individual and enterprise applicants (about 340 applications from individuals and 390 applications from enterprises in 2020). In the Intellectual Property Strategy to 2030, it is supposed that the rate of inventions commercialized is also quite low, about 5% of patents, but needs to be increased by 8-10%. This current situation reveals that scientists' motivation to patent and commercialize their patents have not been sufficiently encouraged due to lack of consistent policies.

Drawing on the motivation theory in social psychology (i.e., STD) as well as literature review and qualitative analysis, this paper offers important insights into the diverse reasons driving motivation to patent and commercialize patented inventions of scientists in academic organizations. In Vietnam, wez found that both the intrinsic and extrinsic reasons directly influence the scientists' motivation in patenting and commercializing their inventions in academic organizations. The intrinsic reasons include prosociality, the joy of achievement, desire to solve challenging technical problems, while the

extrinsic reasons include prevention of imitation, signalling, freedom to operate, revenues generation, blocking competitors (from patenting), and rewards like recognition, prestige, salary, promotion, and research funding (for commercializing). Beyond the extrinsic reasons such as pecuniary or financial rewards, this paper highlights the role of intrinsic reasons, especially prosociality and the desire to solve challenging technical problems, in driving the patenting and commercializing endeavours of those scientists. This is because intrinsic reasons have long been recognized by social psychologists as factors influencing inventive activities but is neglected in much of the existing studies on scientists' motivation. The prosocial reason plays an important role in encouraging scientists to file patent applications. In addition, some authors argue that for those scientists, patenting and commercializing engagement represents a kind of puzzle that satisfies their desire for solving technical challenges and pursuing inventive activities. Based on these arguments, policy makers need to consider a variety of factors including not only extrinsic rewards, but also personal and social aspects related to intrinsic desires.

Based on qualitative analysis, we contribute the following initial explorative findings to this context and some discussions. Firstly, we recognize that weak university-industry collaboration is one of the most typical and common features of academic organizations in Vietnam. This limitation seems to be due to the lack of entrepreneurship among scientists as well as the focus on prosocial-related aspects when defining and solving the technical problems of the inventions leading to obstacles to patenting and negative affection of the scientists' motivation to file the patent application and commercialize their patented inventions. The more useful the invention is, i.e., the invention satisfies a need of the market and industries, the more likely it is to be successfully commercialized and benefit scientists. Conversely, many inventions that are created but are not useful or commercially viable will not contribute to economic growth or increase social benefits. Therefore, in view of public policy, in order to further motivate scientists so that more new and useful inventions are generated and patented, policy makers need to focus on prosociality of inventive activities. Apart from taking a much account to education of students' creative capacity, the current policies in education, especially in the fields of technology and technical sciences, should be improved to form a perspective of taking and benefiting the community when students come to solve technical problems. Simultaneously, to explore and identify existing technical problems, practical activities in the curricula of education may allocate sufficient time for students' social experience and an essential goal of the practice should be based on finding relevant solutions benefiting the community. Secondly, we also find that, in academic organizations, financial benefit is a particularly important factor in encouraging scientists to file patent applications and commercialize their patented inventions, however, in practice this has not been paid sufficient attention by these organizations. From a policy perspective, scientists need to be guaranteed adequate financial benefit, which is commensurate with the commercial value of their inventions through the regulations on transparently allocating that benefit between the organizations and its scientists. We also argue that it is necessary to have a policy on harmonizing materials and benefits for scientists in the case of international publications and patents, according to which in addition to the benefit of being honoured and promoted in academic rankings similar to the international publications, a scientist with commercialized patents also enjoys regular income from the commercialization of their inventions. Thirdly, our analysis draws

attention to an improvement of internal capacity of patented technology commercialization in academic organizations by development of their own technology transfer offices (TTOs). While the public financial resources supporting scientists need to be reallocated with a view to intensifying a firm's budget, there is the fact that TTOs may be relatively poor sellers of patented inventions. TTOs need to prioritize building a patent licensing system that engages closely with enterprises to increases the applicability and marketability of patented inventions as well as scientists' opportunities, capacities, and rewards. TTOs could enhance patent licensing outcomes by paying attention to the mix of reasons for motivating scientists in patenting and commercializing patented inventions rather than to the technologies or inventions themselves. Focusing on those reasons can lead to early collaboration with industry on research design and invention development as well as consideration of marketability and applicability of inventions as an essential part of inventive activities.

COMPETING INTERESTS

The author declares that there is no conflict of interest regarding the publication of this article.

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