Exploring faculty profile and technology transfer initiatives of a newly-instated state university in the Philippines

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Article Info

ABSTRACT

The current university standards of research productivity focus on commercially adopted innovations in various industries. However, as a newly instated university in the Philippines, the Sorsogon State University's research outputs in various disciplines are still lacking the necessary technology readiness level (TRL) that the industry requires. This descriptive method of research using correlation design utilized archival sources to determine the association between the faculty profile and the TRL of research outputs of the university. It was found that more than half of the 194 regular faculty members are specializing in soft sciences which resulted in the dominance of the basic type of research (250 out of 296) conducted from 2015 to 2020. Using the nine-point National Aeronautics and Space Administration (NASA) scale, the study revealed the right-skewed distribution of TRL assessment of faculty research outputs by area of specialization, almost all reaching TRL 1-4 and were not transferred to the intended beneficiaries. Factors such as academic rank, area of expertise, and highest educational attainment of faculty members were significantly associated with the TRL of their research outputs. Faculty members with the appropriate expertise and education preparation may be given the opportunity to collaborate with potential industry partners as part of the re-engineering process of the university's research function.

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1. INTRODUCTION

Universities as an agent of science and technology-based economic growth and development are expected to generate commercialized knowledge and technology addressing global trends and workplace requirements [1]–[3]. It is generally accepted that university academicians are considered the transmitter of knowledge through teaching and a generator of knowledge through research [4]. University scientists in different areas of discipline in our modern period actively participated in technology transfer towards entrepreneurial activities of the derived research outputs while preserving their academic role identity [5], [6].

It is clearly stated in the Philippine Commission on Higher Education (CHED) Memorandum Order No. 46, s. 2012 defining the role of universities in knowledge creation through research and development should contribute to nation-building. Universities should establish a pool of faculty members who participated in research and development activities in their respective fields of disciplines [7] as evidenced by

their scholarly works such as publications, patents, citations, commercialization, and among others. There is importance in the involvement of each university faculty member in knowledge and technology creation as a mechanism for building the nation's human capital while polishing their understanding of their field. Participation in research and development directly improves the quality of teaching.

Along with the changing role and expectations of the universities, faculty members are expected to carry out academic responsibilities that go beyond the classroom such as technology transfer, knowledge dissemination, or community extension services, among others [5], [8]. The conversion of any public higher education in the Philippines including the Sorsogon State College (now a state university) may lead to the re-engineering of its research functions as directed by CHED that would propel the progress of the industries and communities it served.

There have been changes in the internal and external environments of academic institutions that greatly affect the faculty members of any higher education institution (HEI). Different factors such as job resources, job demands, or demographic factors affect the faculty member's ability to perform their duties as an educator and a researcher [9]. A study conducted in the Iraqi higher education system provided a framework for the universities to pay greater attention to research funding opportunities, encourage collaboration among researchers, strengthen information and communication technology (ICT) facilities, and improve job satisfaction to boost research productivity among faculty members [10].

Research Productivity, in reference to higher education, pertains to "publications of papers in professional journals, in the shape of books or presentation of research papers in conference proceedings" which is usually used as a major parameter for faculty promotions [11], [12]. However, the current industry demands modified standards of research productivity focusing much on its outcomes and utilization such as patents, technology transfer, and commercialization [7], [13].

It was identified that high ratios of students in a university to faculty in different field correlate with research productivity [14]–[17] which further claims that the size of an institution with better research programs yields higher research productivity from its faculty members. Several studies revealed that research productivity among public universities is predicted by the qualifications, research environment, funding, and time available to university staff [18]–[20]. An increase in ability and self-efficacy means an increase in research productivity [21]. Moreover, the average research productivity from faculty members seems to drop with seniority in the faculty, however, there is no direct correlation to age but with the increased workloads of senior faculty members [10] which are all impacted by the type of human resource policy schemes and existing research infrastructure [22].

Research does not stop in publication. Instead, research should be a gateway for technology transfer and commercialization as a new dimension of research productivity in higher education institutions [1], [3], [4]. Technology readiness level (TRL) is used as an indicator to assess the maturity of research-based products or technology. Parameters are used to evaluate each technology project and to assign a TRL rating (ranging from 1 to 9) based on the research progress [23]. Technology is vital in improving the economy of a nation, especially in developing countries with industrial growth is given importance [24]. Technological advances are linked to economic progress and social benefits wherein higher education institutions are tapped in maximizing research products.

To sustain the commercialization phase of any technology produced by public research institutes there is a need to ensure the correct level of technological readiness of the research outputs [25]. It is in this sense that there is a shift in terms of research productivity focus among research institutions in the Philippines and the world assessing the readiness of any research products or technology as one of the major outcome indicators of research services which might lead to further investigation, innovations, and improvement.

There are four different approaches introduced to the development of a model [26] in evaluating the maturity level of HEIs research outputs based on the TRL. The current investigation utilized a nine-point National Aeronautics and Space Administration (NASA) scale [23], [27] which measures the maturity level of a technology throughout its research, development, and deployment phase progression. Each research-based technology is evaluated against the parameters using the NASA instrument to assign a TRL rating with 9 as the most mature technology.

Similarly, a study conducted in Indonesia on the utilization of inventions as the output of 442 research projects from 2015 to 2019 in response to the prescription of the National Innovation System (NIS) emphasized demand-driven research results that contribute to the national economy [28]. Their investigation found that many of these research outputs were not pursued higher TRL which needs strategic policy steps to guard those research outputs that have reached high levels of TRL (8 or 9) for industry or community adoption. It is in this sense that the current investigation wanted to show evidence of the faculty members' participation and capability in producing research outputs with the right evidence of TRL for industry and/or community adoption based on the respective qualifications or field of specialization. This study hopes to

provide inputs for the redirections of research programs and policies to ensure the institutional research impact of the newly instituted university to its immediate beneficiaries.

Technology is defined as "all the knowledge, products, processes, tools, methods, and systems employed in the creation of goods or in providing services" [29]. Technology transfer may be defined as the process whereby inventions or intellectual property from academic research is licensed or conveyed through use rights to industry [29], [30]. It is important to emphasize the creation of systems and the operation of those systems under technology transfer.

Technology transfer has become more integrated into universities as it became increasingly recognized for the role it plays in the knowledge-based economy. Universities provide potential spheres for advancing technology, agriculture, and medicine and therefore improving quality of life by transforming research into innovation. The process of technology transfer begins with identifying discoveries that can be protected under intellectual property (IP) and can be marketed into the commercial marketplace. It is therefore recognized that technology transfer promotes a new paradigm for the university's research activities where generated knowledge is translated into a tangible project capable of technological growth and community development [31].

The Philippine Republic Act 10055 was signed into law on March 23, 2010, also known as the Philippine Technology Transfer Act of 2009 which became a landmark for science and technology policies. Moreover, the 1987 Philippine Constitution, Article XIV, Section 10 emphasizes giving priority to research and development, invention, innovation, and their utilization while supporting the indigenous, appropriate, and self-reliant scientific and technological capabilities toward the country's productive systems. The constitution also supports the protection and exclusive rights of scientists, inventors, artists, and other gifted citizens to their intellectual property and creations, especially those that would give benefits to the people, for such period as may be provided by law (Article XIV, Sec 13).

Higher education institutions (HEIs) and Public Research Institutions (PRIs) need effective intellectual property management to pursue technology generation and transfer. An intellectual property policy provides structure and a manageable environment that can guide researchers, faculty members, and students in pursuing their technological research. This new paradigm for universities is a big challenge and an opportunity at the same time for a newly-instated state university such as the Sorsogon State University in the Philippines in producing research-based products and technologies utilizing the available resources as raw materials capable of improving the economy of the locality it serves.

There have been several developments and milestones in the research functions and activities of the Sorsogon State University since its establishment as a Trade School in 1907, as a College of Arts and Trades in 1953, and as a State College in 1993, until it was converted and certified by CHED as a university in 2021. The legalization of the Sorsogon State University through the Philippine Republic Act No. 11088 positioned the institution to work in partnership with communities, businesses, and industry in facilitating the transfer of knowledge or technology on specific developmental areas along with the mandates that directly affects the lives of individuals and communities. The institution has developed several research and non-research-based technologies and products made from indigenous materials across the various degree programs and disciplines offered in the university since its existence.

However, with the industries' evolving demands on the utilization standards of the developed products and technologies, the university has not yet produced successful technology transfer through commercialization. It is, therefore, necessary to determine the technology transfer capabilities of the institution in different areas of discipline based on faculty members' profiles as an accepted factor on research productivity. The outcome of this investigation will serve as a guide in pursuing and enhancing technology transfer initiatives to maximize the research impact and better serve its immediate beneficiaries.

2.   RESEARCH METHOD

This descriptive method of research using the correlational design explored the research productivity profile and the technology transfer initiatives of the newly-instituted university through the existing records and documents. The data gathered from the archive sources [32], [33] both print and digital were subjected to analysis using the quantitative approach. The study explored the institutional research accomplishments and capabilities of faculty members (gender, academic rank, area of expertise, and education) vis-a-vis the type of research conducted (basic or developmental), research output profile, and research output utilization.

2.1. The sample

The study purposively involved the research accomplishments of 194 regular faculty members from 2015 to 2020 at the Sorsogon State University, Philippines, and was subjected to analysis. The purposive non-probability sampling design becomes useful when the study population is chosen subjectively and intently based on the objective of the study [34]. The current investigation has surpassed the recommended

minimum of 100 subjects for a descriptive study [35]. Inconsistent data across the covered period were omitted to secure the study requirements which resulted in 194 samples of regular faculty from the university.

The area of expertise based on the educational attainment of the faculty members was categorized as teacher education, social sciences, natural sciences, industrial technology, information technology, engineering, and architecture. The data on completed research were categorized as either basic or developmental type and presented using appropriate table by area of expertise of the proponent faculty members. The identified research output of faculty members was reviewed and determined whether submitted already for intellectual property protection. The utilization of each research output in any form such as for teaching/instruction, community extension projects, income generating projects (IGP), or commercialization was also subjected to profiling. These initiatives resulted in the identification of the TRL of each research output generated by the faculty members.

2.2. The instrument

The assessment of the TRL of each research output of faculty members utilized the current nine-point National Aeronautics and Space Administration (NASA) scale [23], [27], which measures the maturity level of a technology throughout its research, development, and deployment phase progression. Each research-based technology is evaluated against the parameters using the NASA instrument to assign a TRL rating with 9 as the most mature technology. Workshops have been conducted with the concerned technology generators of the institution to determine the TRL of each research output produced.

2.3. Data analysis procedures

The usual frequency counting and percentage were translated into appropriate charts and tables were used in the data presentation. The Chi-square (X^2) test of independence was used to measure the association between faculty profile and TRL of research outputs. To comply with the X^2 contingency table requirements, the TRL categories as a measure of research productivity were none (absence of research output=0 TRL), basic information established (TRL=1), and technology concepts formulated/experimented/validated (TRL$\geq$2). Microsoft Excel, JAMOVI free software as well as licensed SPSS were used in the statistical computations and presentations of both the descriptive and inferential data for confirmation and to ensure uniformity of the results.

3.   RESULTS AND DISCUSSION
3.1. Insights on faculty profile and research accomplishments
3.1.1. Faculty profile and research generated

This section highlighted the faculty members' capability in producing research work in their own field of specialization based on educational qualifications. More than half of the 194 regularly employed faculty members are specializing in the field of teacher education (55 or 28%) and social sciences (46 or 24%). The data in Table 1 also illustrates that less than 20% of the regular faculty members are specializing in the field of natural sciences, engineering, and information technology.

Table 1. Academic rank of faculty members by area of expertise

Area of expertise	Instructor I-III	Assistant professor I-IV	Associate professor Prof. I-V	Professor I-VI	Total	Percentage (%)
Teacher education	18	16	16	5	55	28
Social sciences	19	13	13	1	46	24
Natural sciences	6	2	7	1	16	8
Industrial technology	13	10	15	1	39	20
Information technology	11	7	1	0	19	10
Engineering	4	5	3	0	12	6
Architecture	2	3	2	0	7	4
Total	73	56	57	8	194	100

The data reveals that out of 194 regular faculty members, 189 obtained graduate degrees (149 master's degree holders, 40 doctorate degree holders), and 140 of them have degrees vertically aligned to their area of expertise (119 master's degree holders, 21 doctorate degree holders). The data also shows that only 72% (140 out of 194) of regular faculty members have educational qualifications specializing in their own area of study with the majority of them in the field of soft sciences. It can be noted also in the figure that

only two faculty members are Ph.D. holders specializing in natural sciences and only three are Ph.D. holders specializing in industrial technology. This shows that areas of expertise in the institution are dominated by the non-science, technology, engineering, agriculture, and mathematics (non-STEAM) related degrees such as teacher education and social sciences.

The data shows that faculty members are generally young in service as revealed by the majority of them are at instructor level (73 out of 194) of their academic rank. Very few of them obtained a professorial level (8 out of 194) of academic rank, all are Ph.D. holders. Out of eight full-pledged professors of the institution, only four of them have vertically aligned educational backgrounds up to Ph.D. degrees and the other three obtained a vertically aligned master's degree. The data also shows that there is only one vertically aligned Ph.D. natural science full professor specializing in biological science while the other three Ph.D. full professors are specializing in teacher education. These figures imply that very few of the faculty members are establishing their expertise in their own field which could be strengthened through the introduction of an enhanced institutional human resource development program.

Figure 1 displays that out of 296 accumulated completed research projects from Fiscal Year (FY) 2015 to Fiscal Year 2020, almost 75% were led by faculty members with teacher education (130 or 44%) or social science (86 or 29%) as an area of expertise. Very few of the engineering (7 out of 296), information technology (10 out of 296) and architecture (only one) faculty members led research projects for the past six years.

The data as provided in Figure 1 is a call to strengthen research and innovation among the faculty members. The institution may provide opportunities for the faculty members to explore and generate knowledge in their own field aligned with the thrusts and priorities of the line government agencies. The STEAM-related program such as natural sciences, industrial technology, engineering, information technology, and architecture programs may work hand in hand with the social sciences to strengthen their research capabilities and increase their opportunities to develop innovative research projects in their own area of expertise that would offer solutions to societal problems.

3.1.2. Research output profile

The data reveals that only 16% (46 out of 296) of the accumulated completed research projects of faculty members from FY 2015 to FY 2020 are developmental types of research. Basic type of research (250 or 84%) dominated the majority of the faculty members' research accomplishments by area of expertise. This data further signifies that the institution may provide higher priority to developmental-type research projects led by faculty members to emphasize innovations that would increase higher societal impacts. The faculty members may be provided with options integrating basic research components to the developmental type of research and vice-versa to give higher chances of collaboration among multi-disciplined experts.
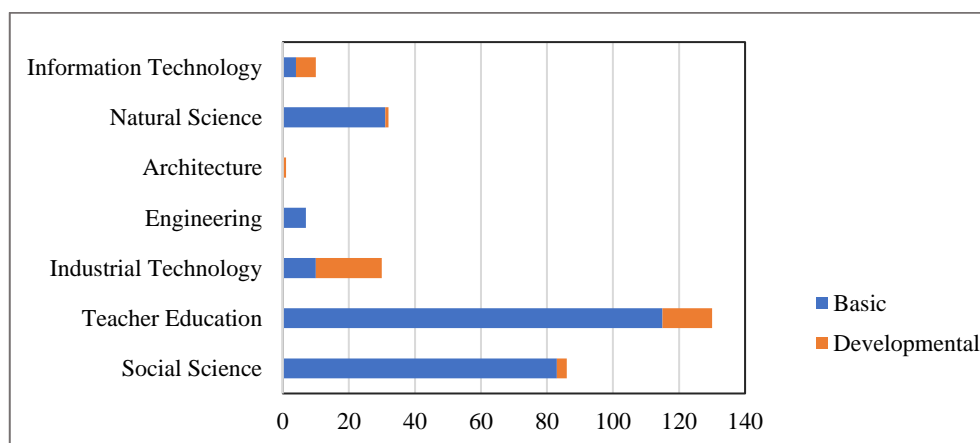

Figure 1. Number of research conducted by area of expertise in 2015–2020

The research outputs generated out of a developmental type of research need to explore its further utilization benefitting the intended beneficiaries. One of the essential prerequisites prior to dissemination and knowledge diffusion to pursue technology transfer of research outputs is the intellectual property protection to ensure its originality and inventive step towards greater impact that would offer solutions to existing problems in the community or industry.

The data on IP protected outputs from developmental type of research conducted by faculty members illustrates growing number of protected research outputs as a newly-instated university. This data demonstrates faculty members' awareness of the importance of IP protection as prerequisites towards technology transfer and/or research utilization. There was a total of 29 research products (63% of 46 developmental research) submitted for IP protection since 2015. Most of them (17 out of 29) were submitted for copyrights, three for trademark application, and seven with utility model (UM) certification from Intellectual Property of the Philippines (IPOPHL), and two with patent pending certification.

The data on IP protection signifies that the institution should continuously provide higher priority to patent as a measure of inventions among scientist (professors) of the institution as a university aiming for excellence and international recognition. Those generated certified UMs out of research products should be pursued for its appropriate technology transfer with commercialization as the highest form of utilization that would provide income for both the adopters and the university prior to the expiration date of its grant/privilege.

3.1.3. Research output utilization

The utilization of research output may depend on the type of research conducted which may take in the form of knowledge-transfer of basic type of research and technology-transfer of developmental type of research. Transfer of knowledge from research may be made through policy reforms or enhancements, technical assistance/services to agencies, consultancies, among others which may lead to further research and development. Technology transfer of research outputs may be made through the introduction of income generating projects (IGP), extension projects, copyrighted books or instructional materials, and/or commercialization.

The data shows that there was a total of 50 out of 296 research projects completed (basic and developmental) utilized for the past six years. Figure 2 emphasizes that majority of the forms of utilization across time were for community extension project purposes. Majority of the research-based extension projects (17 projects) emanated in FY 2016 with the addition in the preceding fiscal years which resulted to a total of 44 research-based extension projects.
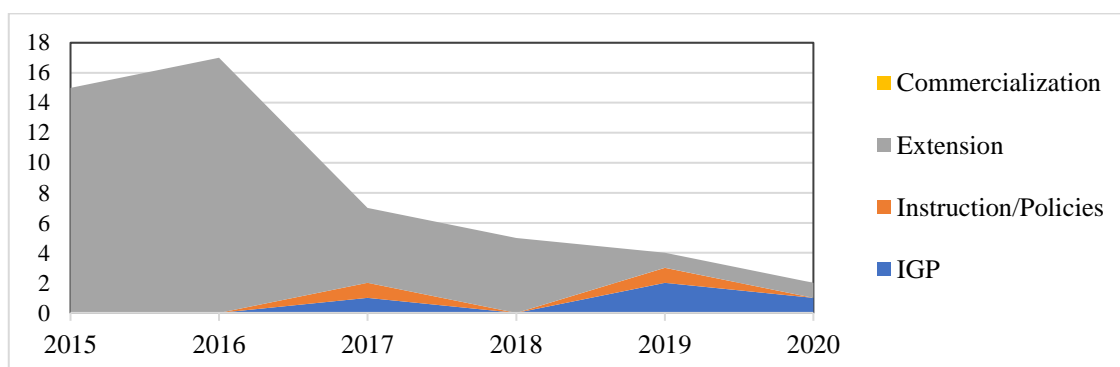

Figure 2. Forms of utilization of research outputs

There were 12 of 44 extension projects products of developmental type of research together with 32 basic types of research. This data also shows that the type of extension projects the faculty members are providing to the community where majority of them are into provision of new knowledge or information through trainings and seminars. Research-based extension projects are certainly a requirement not only by the governing bodies but also in pursuing for quality and excellence of any project engagement by a university as provided in several instruments such as AACCUP, Inc, Center of Development/Excellence (COD/COE), SUCs typology and ISA standards.

Figure 2 also shows that very few of the research outputs were utilized for IGP (4 out of 50) and instruction or policy enhancement purposes (2 out of 50). The utilized research for IGP and instruction purposes are the output of developmental type of research. The figure further illustrates that the institution needs to prioritize activities towards the commercialization of research outputs especially those which are already IP protected. If those IP protected research outputs will not be pursued for commercialization, they will be utilized for public good through community extension projects, training and workshops, teaching, and the like.

3.2. Technology readiness level of faculty research outputs

The TRL assessment of faculty research outputs by area of expertise reveals the right skewed distribution as shown in Figure 3. The skewness can be associated to the majority of the faculty members in social science or teacher education as area of expertise with basic research outputs categorized at TRL1 (basic principles observed) to TRL 2 (Technology concept formulated). Moreover, all the engineering and natural science faculty members with research outputs categorized as TRL 1 aside from the 57 faculty members which have no completed research yet (TRL 0) in their area of expertise. The faculty member research outputs and/or generated knowledge still has room for more improvements and to scale up towards technology development, experimentation, and demonstration both in the laboratory and actual environment to pursue commercialization activities.
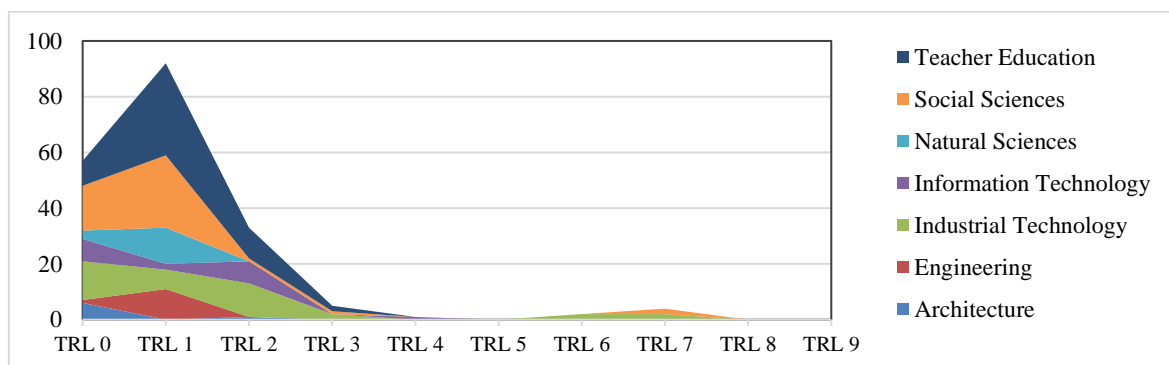
Figure 3. TRL by area of expertise

The data also reveals that very few of the faculty members with research outputs reached at least the TRL 6 (prototype demonstration in operational environment) as shown in Figure 3. There are four identified research outputs (all are food products) that reached at least TRL 6. These research outputs were contributed by four industrial technology faculty members' together three social science faculty members.

Universities, along with government funding sources, focus on TRLs 1-4, while the industry and other private sectors focuses on TRLs 6-9. The data signifies that the institution may provide opportunities to faculty members to explore partnerships and collaborations with the intended beneficiaries and the industries as potential adopters of their researches being pursued for the past years.

Exploring partnership with the industry along with the technology research and development will ensure translation of knowledge into a commercialized output benefiting the community. The HEIs faculty members as transmitter of knowledge will be given opportunities to work with the industry, that whatever inventions or products they made out of researches will become relevant to the operational environment, fitted and appropriate to the industry-system and context.

3.3. Association between faculty profile and TRL of research outputs

Table 2 shows the test of association between the faculty profile and research productivity using the chi-square (X^2) test of independence at 0.05 level of significance. The data reveals that the academic rank ($X^2=22.80$, $p<0.05$), area of expertise ($X^2=7.18$, $p<0.05$), and highest education attainment ($X^2=14.10$, $p<0.05$) are all statistically associated with the TRL of their research outputs.

Table 2. Association between the faculty profile and TRL

Faculty profile	N	X^2	df	p-value	Cramer's V	Remarks
Gender	194	4.79	2	0.091	-	Not significant
Academic rank	194	22.80	4	<0.001	0.242	Moderate
Area of Expertise	194	7.18	2	0.028	0.192	Weak
Highest education	194	14.10	2	<0.001	0.269	Moderate

The Philippine CHED directed that regular employment for a position in a state university requires a minimum educational qualification for faculty members to have at least a master's degree. Thus, it is understood that all faculty members with permanent appointments possess the minimum qualification in their own area of expertise. Their academic rank will depend on their accomplishments in professional

development, research work, and community extension projects. The result of this investigation confirms that higher research productivity measured by TRL of research outputs increased with higher academic rank. Also, the research skills of faculty members are expected to increase while obtaining higher academic rank [21]. As the skills of faculty members in pursuing technological research increase, the quality and readiness of research products they produce also improve, which in turn results in higher research productivity.

Faculty members with the STEAM-related area of expertise are more likely to have research outputs with higher TRL. These are faculty members with outputs from their developmental type of research related to food technology, information technology, industrial technologies, and the like. The university has offered curricular programs for a long period of time related to technology courses originally vocational courses with its core faculty members who have developed matured products. Moreover, faculty members who possess doctorate degrees are more likely to have research outputs with higher TRL. It is therefore necessary that the institutions may provide opportunities for faculty members to acquire higher educational qualifications to further develop their skills, innovative minds, and creativity along with their area of expertise using the available resources in the locality. Generally, the higher educational qualification of the faculty members along with their area of expertise leads to better research productivity [36].

The gender of faculty members, however, was not significantly associated (X^2=4.79, p>0.05) with their research productivity. Both male and female faculty members can contribute to the research accomplishments of the institution and vice versa. The readiness of the developed technology of faculty members will only depend on their initiatives to make it a usable product beneficial to the community.

4.   CONCLUSION

Exploring research productivity profiles by academic researchers is of undoubted interest to practitioner audiences, notably policymakers and university managers. Government agencies and universities themselves have made concerted efforts to increase academic engagement, for reasons ranging from generating societal legitimacy for publicly subsidized scientific research, stimulating economic activity to raising revenue for universities. Following the analysis of existing records and documents to determine the productivity profile of the Sorsogon State University in pursuing transfer of technology from research projects, the succeeding conclusions can be drawn.

Firstly, the research profile of the faculty members has outputs notably leaning more towards basic research under soft sciences done by relatively younger ones. The number of senior faculty members with vertical expertise who can pursue developmental research, as well as external collaborative engagement are low. Secondly, minimum TRL of research outputs are observed for a few of the developmental research output. Lastly, factors such as academic rank, area of expertise, and highest educational attainment of faculty members were significantly associated to the TRL of research outputs.

As TRL has been defined as a scale used to assess the maturity of a technology (e.g., device, material, component, process) on an entire scale - from its invention to commercialization efforts and wide-scale application, that, in turn, determines the number of resources - time, funds, intellectual potential, facilities- necessary to bring this technology to life. Thus, having low TRL for most technology already directs the institution on what aspect of the whole process should be given more value as well as what aspect of faculty members' capability needs to rethink to pursue transfer of technology. The strategic redirections and re-engineering of the plans and programs of the university for an intensified demand-driven knowledge and technology creation for industry adoption need to be in place according to the area of expertise and qualifications of the faculty members. Technology Business Incubation (TBI) hubs be established in the university for further explorations and enhancements of the developed research-based products or technologies with a higher level of TRL that would open opportunities for technology licensing agreements (TLAs) with the interested industries and communities. It is therefore recommended to pursue studies of industries' needs and the potentialities of industries in the locality based on the available local natural resources for expansion vis-à-vis the available human resource experts of the university.

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