Journal of Scientific & Industrial Research
Vol. 82, September 2023, pp. 956-965
DOI: 10.56042/jsir.v82i9.1358

Understanding Successful Transfers of Rapid-Composting Technology Using Qualitative Content Analysis for Interpretation

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Received 10 May 2023; revised 17 July 2023; accepted 09 August 2023

This study focuses on the transfer of technology of rapid composting of bio-waste from a Public-funded Mission-oriented Research Organization (PMRO) in India. The PMRO is engaged in developing nuclear power technologies, and applications of nuclear technologies to non-power areas such as agriculture, bioscience, health care, and industry. It also develops technologies for applications in many areas including electronics, computers, LASERs, and accelerators. The organisation encourages the transfer of spin-off technologies for commercialization as well as for scaling up under incubation on a non-exclusive basis. The technology under study has attracted a large clientele of over 50 transferee firms in 5 years. This paper explores motivations behind a large clientele. While academic literature substantially covers the technology transfers from universities, the PMROs, especially those in emerging economies have not received much attention from academics. This paper *inter alia* addresses this gap. Semi-structured interviews were conducted with the actors namely scientists, tech-transfer managers, and executives of transferee firms. Qualitative content analysis was carried out to arrive at the success-enabling factors, success-inhibiting factors, unique processes, and special roles of actors. Also, the paper brings out the strength of qualitative content analysis as a concept interpretation method in case study research. The paper highlights the synergistic interactions between the industry and the laboratory and provides useful tips for scientists, Tech-transfer Managers, and executives of transferee firms for making success in tech-transfers of societal and environmental technologies.

Keywords: Proactive technology seeker, Public-funded mission-oriented research organizations (PMRO), Social capital, Technology transfer

Introduction

Technological innovation is the major driver of the economy surpassing the influence of labour and capital as drivers.[1] However, technologies are expensive to produce, but quite inexpensive to reproduce. Hence, the firm that had invented a technology might end up quoting a higher price than another firm that might reproduce the same technology at a much lesser cost. This makes the inventor firm prone to fail in the market, a phenomenon that may be called market failure. To avoid market failures, the government intervenes by setting up research organizations to provide technological inputs to industrial firms to ease the uneven competition.[2] In the context of India, the Council of Scientific and Industrial Research (CSIR), set up in 1942, exemplifies such Public-funded Research Organizations (PROs).

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Among PROs in India, there are three research organizations devoted to strategic missions of defense, nuclear, and space technologies, called Public-funded Mission-oriented Research Organizations (PMROs).[3] These mission organizations are world-class and develop technologies that are reliable and of high quality. The PMROs in India, in addition to fulfilling the mission requirements, use their expertise to serve the general industry with techno-economically competitive products and processes.

The focus of this study is a PMRO in India, established in 1954 to develop power and non-power applications of nuclear technologies. It is a multidisciplinary research organization having about one hundred research divisions having around 7000 scientific and technical staff in its main campus located in Mumbai. PMRO is part of the Department of the Government of India.[4] Many industrial units are also a part of the same Department. The technologies developed by the PMRO at the lab and/or pilot scale are transferred to and deployed by the industrial units of the Department. For example, technologies related to the front end of the fuel cycle are transferred to the Uranium Corporation of India Ltd. (UCIL), the Nuclear Fuel Complex (NFC), and the Heavy Water Board. Nuclear power reactor technologies are transferred to the Nuclear Power Corporation of India Limited (NPCIL). Electronics and instrumentation technologies are transferred to the Electronic Corporation of India Ltd. (ECIL). Also, the Department encourages the private sector to deploy applications of nuclear technologies to areas such as health care, agriculture, and industry but provides radio-isotopes and radiation equipment through the Board Radiation and Isotope Technology (BRIT). The Department through the PMRO also provides education and training to enable safe deployment of non-power applications by the private sector.[5]

The PMRO transfers spin-off technologies under license on a non-exclusive basis at the existing Technology Readiness Level (TRL) or after modifications in collaboration with the industry. PMRO has also used its expertise for developing technologies for the general (in addition to nuclear) industry and society. There are around 260 spin-off technologies available for transfer in eight fields namely agricultural, radiation instrumentation, medical instrumentation, advanced instrumentation, environmental, chemical, engineering, and water technologies.[4]

The PMRO has also been studying the biological effects of radiation on humans and the environment. The expertise so acquired was used by PMRO to develop and deploy biogas plants to achieve volume-reduction of biodegradable waste, accompanied by the generation of biofuel.

On knowing PMRO's success in biogas technology from social contacts with the scientists, a housing society requested a technology to treat dry coconut leaves accumulated at their premises. Spotting the potential of the requested technology for sustainable development, the biologists of PMRO responded positively by using their relevant core competence. After successful development at the lab scale, the scientists embarked on scale-up by leveraging not only intra-organizational collaborations but also the practical experience of the technology seeker. The technology so developed has features of rapidity, versatility (customizable to a variety of wastes), and simplicity (single organism application), and proved better than conventional composting methods. The features of technology were appreciated by many takers. Initially, the rate of tech-transfers per year was 7 Nos. per year. This increased to around 12 Nos. per year within five years, indicative of successful technology transfers (tech-transfers, hereafter) concerning the size of clientele.

The success of transfers of this technology motivated this study. Moreover, tech-transfers from PMROs, especially in emerging economies have remained under-studied compared to those from universities.[6–8] Hence one of the objectives of this paper is an attempt to fill this research gap.

Further objectives of this paper are the following:

- To identify the enabling and inhibiting factors for the success in developing and transferring the technology and drawing a large clientele.
- To explore the special roles played by various actors in making a success of the tech-transfers,
- To understand the unique processes underlying the success of the tech-transfers.

Key features of the research are depicted in Fig. 1.

This work contributes to the literature in three ways. First, it describes the characteristics of the PMRO taking up the development and transfer of technologies (on a non-exclusive basis), as well as the positive role of the social capital of scientists. Second, it describes how collaboration with the proactive technology seeker can enable the development of a viable technology and result in many more successful

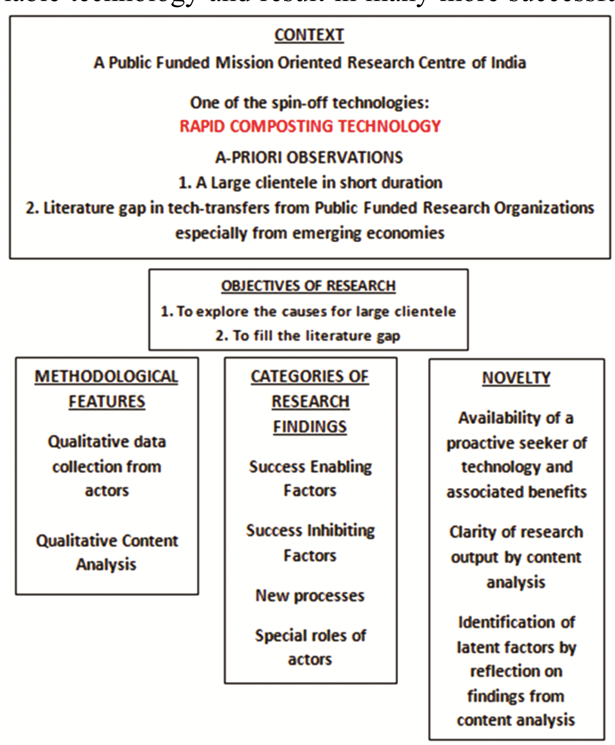

Fig. 1 — Key features of the research

transfers. Third, it illustrates the clarity inherent in the method of qualitative content analysis for uncovering the findings of studies of this kind. The findings from the paper also provide tips to practitioners.

The Conceptual Background

PMROs

Government-run research organizations comprise universities and PROs. Though university research has its importance, particularly in early-stage development, the economy largely depends on technological research carried out in industrial research centers, both public and private. In India, PROs are the major generators of technologies in comparison to universities and private industry.[3,9]

Many scholars have written extensively about tech-transfers from publicly funded research organizations.[3,10–15] Among the public-funded research centers, the mission-oriented ones serve certain strategic national missions such as defense, space, and nuclear, which are not easily served by the private industry.[10] In India, the merit of PMROs stems from the fact that the departments running them also manage their industrial units and thus provide in-house clientele for the research output.[3] In-house clientele provides several advantages such as the ready availability of a taker and intimate user feedback on the performance of the technology. To serve their mission, PMROs have large manpower with diverse specializations engaged in both academic and post-academic research. They are equipped with state-of-the-art sophisticated experimental facilities.[3,10]

Some scholars suggest that early identification of the potential of the technology for commercialization would make the research output more likely to be successfully deployable.[16] This point is well exemplified by the technology of interest in this paper.

For the success of tech-transfer, it is desirable that the firms partnering with government laboratories possess characteristics such as familiarity with the unique resources of the lab, desire to develop new products and services in line with the capabilities of the labs, access to skills and knowledge of scientists in the labs, and adequate technical experience.[17] Some of the successful firms featured in this study do possess these characteristics.

Rapid-Composting Literature

Composting is the controlled conversion of biodegradable organic wastes into a low-volume stable product called *compost* which is used as a soil nutrient. Conventional composting is a very slow process. As the name suggests, the process involved in this technology is faster because of the use of a special strain of fungus called *Trichoderma koningiopsis* that decomposes cellulose, the main constituent of biodegradable waste. It was also established that this fungus can degrade various forms of waste such as food waste, floral waste, lawn mowings, and tree shreds. Studies were initially carried out on a lab scale, followed by pilot studies in drums of 100 kg capacity, and finally at tonnage scale at the actual waste generation sites.[18] The composting medium, waste material, and final compost are depicted in Fig. 2.

Tech-Transfer

Manufacturing firms are the key drivers of the economy and thrive on innovative technological inputs, either by in-house R&D or external R&D agencies.[1] To facilitate inputs from R&D agencies to manufacturing firms, it is necessary to devise mechanisms for the transfer of technologies. Tech-transfer can be defined as the movement of technical know-how from one organization to another for the business benefit of the latter, by use of formal mechanisms involving financial considerations.[19–21]

The importance of tech-transfers from PROs was made prominent during the 1980s by the US federal government.[22] In India, the Technology Policy Statement of 1983 was the first such policy to bring forth the importance of tech-transfers.[23] The objectives of this policy included the development of indigenous technologies and the efficient absorption and adaptation of imported technologies appropriate to national priorities and resources. However, the idea of domestic tech-transfers in India is yet to receive the required emphasis, commensurate with the size of the industry.[24]

Not all technology transfers attain the same level of success. Hence many scholars worked extensively on the identification of factors for success or otherwise.[25–28] Some of the important success-enabling factors

Fig. 2 — (a) *Trichoderma koningiopsis*, (b) Shredded coconut leaves, and (c) Final product useful

identified by them are (i) intense handholding of the transferees by the developer, (ii) market-oriented development, and (iii) strong mediation by TTO (Technology Transfer Offices). Important success inhibitors are (a) inadequate publicity about the availability of technology, (b) the high cost of the end product, and (c) heavy competition in the market. Grover[3] identified inter-departmental collaborations enabled by the multidisciplinary structure of the PMRO as an important success-enabling factor. Creative collaboration by the transferee[29] and effective technology marketing[14,30] are also considered important.

The processes involved in tech-transfer are quite nuanced and depend intensely on interactions between stakeholders, also called actors.[13] To ease the understanding of processes and constituent elements of tech-transfers, several scholars have identified some common features of various kinds of tech-transfers and represented them as 'models'. Some models are built based on actors,[31–33] and some are based on chronological processes.[21,34] In this study, the authors used a model based on actors for collecting and analyzing the data.

Methods

This research deals with qualitative data drawn from interviews with a limited number of stakeholders (actors). Therefore, we took up qualitative research. Further, among various approaches to qualitative research such as ethnography and phenomenology, we have taken up the case-study approach since it guides in clearly defining the scope of research and in collecting rich information of diverse forms relevant to answer the *why and how* questions of a contemporary issue on which the researcher has no control.[35] Once the information is obtained, the method of content analysis gives a transparent procedure for drawing insights.[36] Hence, we have used a combination of qualitative case study and content analysis.

Case information was obtained from the key actors namely technology developers (Scientists), Technology Transfer Managers from TTO (TT Managers), and executives of transferee firms (Executives). Four firms were chosen by purposive sampling based on their diverse characteristics: a housing society, a veteran environmental firm, a veteran agriculturist, and a novice startup. This actor-oriented study follows the Actor-Network Theory which allows investigating and constructing the reality through understanding the practices and interactions of different actors.[37]

Primary data were collected through semi-structured interviews by use of discussion guides. Data collection was iterated two to five times alongside data analysis, to ensure dynamic elicitation of information, called theoretical sampling.[38] Details of primary data collection are given in Table 1.

Secondary data were obtained from (a) records of the TTO of the PMRO (b) internal reports of the scientists and (c) scientific publications about the technology. Content analysis of data was carried out at three levels of abstraction with code names chosen by authors to reflect the context. Transcripts of interviews were perused to identify the descriptive codes of each set of actors (Level 1). Descriptive codes of a similar nature were grouped to obtain concept codes (Level 2). The concept codes of similar nature were further grouped to form insight codes (Level 3). The next section gives the details of content analysis.

Content Analysis

Content analysis of descriptive codes of three sets of actors listing interview-discussion points, descriptive codes, concept codes, and insight codes, for each set of actors are given in Table 2, Table 3, and Table 4 respectively.

The notation DS is used to denote descriptive code identified based on the interview of scientists, DT of TT Managers, and DF of firms'Executives. The corresponding concept codes are denoted by CS, CT, and CF, and the corresponding insight codes are denoted by IS, IT, and IF. The codes are numbered DS1, DS2, etc. For codes of firms, an additional numeral such as DF2-1 is used, where 2 denotes the second firm and 1 denotes the first descriptive code of the firm. The concept codes and insight codes were examined for their impact to identify them as findings, which are given in the next section.

Table 1 — Details of primary data collection

	No. of meetings	Mode of meeting	Nature of the data collected
Scientists	5	Email, telephone, and personal meetings	Technical details and information about interactions with other actors.
TT Managers	3	Email and personal meetings	Tech-transfer mechanisms
Executives	3 meetings x 4 firms	Email, telephone, and videoconference	Motivation for license and post-transfer performance.

Table 2 — Content analysis of descriptive codes of Scientists

1	2	3	4	5
Sl. No.	Discussion point	Descriptive codes	Concept codes	Insight code
1	Motivation for developing technology	Proactive request from a societal user. DS-1 Technology of high use-value. DS-2	Proactive request for the technology of high use-value. CS-1	Availability of a proactive seeker of technology IS-1 (SEF-1)
2	Collaboration from proactive seeker	Technology seeker's prior experience. DS-6 Demonstration of systems to new transferees. DS-25	Leveraging the experience of pro-active seeker CS-2	
3	Background strength of scientists	Prior experience in handling fungi. DS-3	Scientific and coordination abilities of scientists CS-3	Strengths of scientists and their laboratory IS-2 (SEF-2)
4	Intra-organizational collaborations.	Coordinated with multiple agencies within the department for development and scale-up DS-4	Multidisciplinary and multi-scale strengths of PMFR. CS-4	
5	Switching from lab scale to large scale	The environment of working both at the lab and large scales. DS-5		
6	Strengths of the technology	Rapidity. DS-7 Low cost. DS-8 Feasibility at the community level. DS-9 Adaptable to a variety of wastes. DS-10. Fewer steps of processing. DS-11. Implementable at the source location of a waste. DS-12	Technological quality CS-5 (SEF-3)	Factors for a large clientele IS-3
7	Commercial strengths	Suitable for start-ups. DS-13 Technology push. DS-32 Demand-pull. DS-33 Being a public-value technology, acceptable to non-commercial takers too. DS-34	Commercial strengths of technology CS-6 (SEF-4)	
8	Drive to proceed to transfer the technology	Simultaneously public-good and commercial technology. DS-14. Ready availability of technology seeker. DS-15 A commercially attractive environmental technology. DS-16.	Motivation to go for tech-transfers CS-7	
9	Whether the market aspect was studied.	Absence of explicit technology marketing. DS-17	Absence of explicit technology-marketing CS-8	Absence of explicit technology-marketing drive IS-4 (SIF-1)
10	Launched at what level of readiness of technology?	Launched at the highest feasible TRL. DS-18	Launched at one readiness level lower than the full scale-up. CS-9	
11	Interactions with tech-transfer officers during development	Absence of scientist-TTO interaction during technology development. DS-19	Absence of scientist-TTO interaction during technology development CS-10	Absence of scientist-TTO interaction during technology development IS-5 (SIF-2)
12	Interactions with TT Managers during the techno-legal process.	TTO's role in innovative publicity DS-20 Deciding transfer-cost, DS-21 Evaluation of tech-transferee. DS-22 Drafting transfer-agreement. DS-23 Establishing the transfer agreement. DS-24.	Special role of TTO CS-11 Normal roles of TTO CS-12	Role of TTO IS-6 [This is a triangulated insight based on interviews with TTO]

(*Contd.*)

Table 2 — Content analysis of descriptive codes of Scientists (*Contd.*)

1	2	3	4	5
Sl. No.	Discussion point	Descriptive codes	Concept codes	Insight code
13	Ways of hand-holding the firms	Training in developer's lab. DS-26 Guidance in sourcing the sub-systems. DS-27 Guidance in assembling & operating the system. DS-28. Guidance in evaluating the product. DS-29	Scientists' intimate help to the transferee CS-13 The special role of scientists	Bidirectional flow of technical knowledge IS-7 (SEF-5)
14	Rich feedback from transferees.	Transferees help in improving the implementation aspect. DS-30 They impel expanding the utility of the technology. DS-31	Transferee's help to scientists CS-14	

Table 3— Content analysis of interviews of TT Managers

1	2	3	5	6
Sl. No.	Discussion point	Descriptive code	Concepts Code	Insights code
1	Support to developers before the tech-transfer process	Technology assessment. DT-1 Help draft technology document. DT-2	Regular role of TTO CT-1	-
2	Activities during the tech-transfer process	Advice on intellectual property, calculation of transfer cost, publicity, evaluation of transferees, and execution of transfer-agreement DT-3		
3	Innovation in publicity	Innovation in publicity by placing on two relevant web-pages DT-4	Case-specific special roles of TTO CT-2	Special role played by TTO IT-1 (Special Role of TTO)
4	Additional technical support beyond 4 man-days or 1 year	To set comfortable terms for post-transfer support DT-8		
5	Royalty	No royalty DT-10		
6	Expansion of user-base	Being a public-value technology, offered to non-commercial takers too. DT-12		
7	Nature of license	Non-exclusive, revocable license DT-5	Non-exclusive license CT-3	
8	Initial training	Initial training DT-6	Terms of license CT-4	
9	Free consultancy for 1 year	Initial consultancy DT-7		
10	Transfer fee	Transfer fee DT-9		

Findings

Drawing upon scholars such as Heslop, the fulfillment of the envisaged outcome by the transferee firm was considered as the success of a tech-transfer in this study.[39] Accordingly, we considered success (enabling/inhibiting thereof) factors not only concerning the quality of technology but also the way the stakeholders acted. For example, one of the transferees had reported having innovated in expanding the scope of application of the technology, signifying the firm's innovation as a finding under the category of Success-Enabling Factor (SEF). Another category of findings identified is success inhibiting factors (SIF).

A context-specific 'new process' and special roles' of the actors that brought success were identified as two more categories of findings. Some of the findings have reflections in the literature identified by references in parentheses. The findings not having any reference are the contributions of this research.

Table 4 — Content analysis of interviews of Executives

1	2	3	4	5
Theme	Firm 1	Firm 2	Firm 3	Firm 4
Background of transferee	A housing society proactively sought the technology. Social contacts of scientists (DF1-1)	Relevantly qualified and passionate. Higher scale business (DF2-1)	Relevantly qualified & passionate Moderate scale business (DF3-1)	SIF: Retired from a different field. Relatively novice (DF4-1)
Motivation to take the technology	Domestic, non-commercial treatment of in-house waste. DF1-2	The reputation of the developer and efficacy of the technology. (DF2-2)	To add to the similar line of business, by use of this effective technology. (DF3-2)	Post-retirement entrepreneurship. High business potential of the technology. (DF4-2)
Strengths	Societal consciousness. Practical knowledge. Congenial interaction DF1-3	High qualification, innovation, large-scale promotion, and manufacture (DF2-3)	Qualification, passion, diversified innovation, and self-expansion DF3-3)	Lower scale manufacturing (DF4-3)
Marketing channels	—	Large-scale clientele accentuated by e-commerce (DF2-4)	Strong personal network DF3-4	Moderate
Comments of transferee	—	This technology is effective and time-saving. DF2-5	High quality, profitable. Reputation of PMRO DF3-5	Difficulty in convincing customers. DF4-5
Challenges to technology	—	SIF: Low cost, less effective, alternatives. DF2-6	—	SIF: Small firms need technical help DF4-6
Technology Absorptive Capacity	Moderate DF1-7	High DF2-7	High DF3-7	Nominal DF4-7
Concept codes	Social contacts of scientists CF1-1 Pro-active seeking (CS-3 and CF1-2),	Competition from lesser technologies CF2-1 High Tech absorptive capacity (CF2-1 and CF3-1)	Demand pull CF3-1	Novice entrepreneur (CF-5)
Insight codes	Social capital of scientists IF1-1 (SEF-6) Cooperative development IF1-2 (New Process-1)	Competing low-cost, less effective technologies IF2-1 (SIF-3)	Technology absorption capacity of transferee IF2-2 and IF3-1 (SEF-7) Demand-pull IF3-1 (SEF-8)	Suitable to licensethe start-ups IF4-1 (SEF-9) Novice entrepreneur IF4-2 (SIF-4)

Following are the four categories of findings with linkages to Table 2, Table 3 and Table 4. The findings were categorized as success-enabling factors (SEFs), success-inhibiting factors (SIFs), new processes, and special roles of the actors.

Success-Enabling Factors (SEFs)

SEF-1: Availability of a proactive seeker of technology (Table 2, column 5, IS-1)

SEF-2: Strengths of scientists and their laboratory (Table 2, column 5, IS-2)[3]

SEF-3: Technological quality (Table T2, column 4, CS-5)[26]

SEF-4: Commercial strengths of the technology (Table 2, column 4, CS-6)[39]

SEF-5: Bidirectional flow of technical knowledge (Table 2, column 5, IS-7)[29]

SEF-6: Social capital of scientists (Table 4, column 2, IF1-1)

SEF-7: Technology absorption & innovation capacity of the transferee (Table 4, column 4, IF2-2 and IF3-1)[40]

SEF-8: Demand-pull (Table 4, column 4, IF3-1)

SEF-9: Suitability for licensing of this technology to startups (Table 4, column 5, IF4-1)

Success-Inhibiting Factors (SIFs)

SIF-1: Absence of explicit technology-marketing drive (Table 2, column 5, IS-4)[14]

SIF-2: Absence of scientist-TT Manager interaction during technology development for techno-managerial support (Table 2, column 5, IS-5)

SIF-3: Competition from low-cost, less effective technologies (Table 4, column 5, IF2-1)

SIF-4: Transferee being a novice in the field (Table 4, column 5, IF4-2)[30]

The New Process

The **new process-1** identified is the cooperative development (Table 4, column 2, IF1-2) by scientists and the proactive technology seeker resulting in an effective technology that was sharply tuned for field use. The process of cooperative development has not been common for other spin-off tech-transfers of the PMRO under study. The clients usually approach TTO after the technology is completely developed and notified to the public. However, it is appropriate to mention here that, the PMRO does carry out cooperative development in the case of mission technologies where the client is an industrial unit under the same organization. Cooperative development is also common while developing technologies for other large government organizations such as Railways, or public sector undertakings such as Indian Oil Corporation, etc. Recently, the PMRO has also set up a Center for Incubation of Technology which invites an expression of interest from the manufacturing industry for collaborative development with an option of exclusive transfer to the successful incubation for a limited duration.

Special Roles of Actors That Made a Positive Impact

1. Special role-1: Intense handholding by scientists (Table 2, Column 4, CS-13), resulting in a bidirectional flow of technical knowledge. This expanded the utility of the technology for a wide variety of wastes that could be treated. This further expanded the clientele.
2. Special role-2: TT Managers carried out supporting roles (Table 3, column 5, IT-1) by expansive publicity, enabling the tech transfers to non-commercial firms, waiver of royalty, and setting comfortable handholding terms in the license agreement.

Discussion

Transfers of the technology under this study are found to be unique compared to those of other technologies from the same PMRO, in terms of new sub-processes of tech-transfers and special roles played by the actors. For example, the scientists and the initial proactive seeker were found to have acted beyond their normal call in implementing cooperative development and further congenial engagement.

The practice of intense handholding by the scientists resulted in instances of bidirectional flow of knowledge. Thereby, transferees had a better understanding of the technology, and the scientists in turn who normally work at a laboratory scale had exposure to the industrial scale. Also, they had the opportunity to tune up the formulation for the treatment of new kinds of bio-wastes, thus expanding prospective clientele. The TT Managers on their part, re-looked at the policy and included non-commercial entities too, considering the societal use of the technology.

This study brought out nine SEFs and four SIFs, out of which five factors find an echo in the previous literature.

There has been a popular opinion among scholars such as Klein[41] that, while scientists of PMROs are largely successful in implementing their mission, they are not quite favorable to reap commercial benefits from their research. Contrary to this opinion, the scientists in this context not only focused on technical excellence, but they also paid full attention to the tech-transfer processes, resulting in many successful transfers. In general, in the PMRO under focus, there are more examples of this, but these are largely for tech-transfers to public sector organizations.[5]

Further reflections by the authors brought to light, a few latent impact factors pertaining to the characteristics of the PMRO, the technology, the industry, and the stakeholders. The PMRO having engaged in the mission of nuclear technologies has characteristics of multidisciplinary capability and propensity for timely implementation, in addition to possessing satisfactory social capital. Hence the initial proactive seeker after having been dissatisfied with certain conventional technologies had approached the PMRO with an implicit faith. The good characteristics of the technology, i.e., rapidity of performance, simplicity in application, quality of product, and ease of adoption by startups, had attracted many takers. The characteristic of the industry of responding to environmental imperatives has been a favorable factor. The characteristic of congenial human interactions among stakeholders made the activities smoother and more effective.

The latent characteristics being broader and context-independent can be generalized to wider contexts. Identification of both visible and latent factors is a novel outcome of this study.

Conclusions

This paper has implications for encouraging tech-transfer situations wherein a mission-oriented laboratory develops a societal technology to meet the requirement of a proactive seeker. The seeker in his interest would share the best of his practical experience and would cooperate in bringing out an effective technology in a short time. This has the potential to result in further tech-transfers to a large clientele. The method of content analysis confirmed its effectiveness for such studies. The findings of this paper will help the stakeholders in bringing about effective transfers of technologies.

Also, considering the 3M framework, i.e., Motivation, Mechanism, and Mode, the authors have the following to say: The motivation of the scientists was to ensure a clean environment through the transferee firms. The motivation of the TT Manager was to support the scientists and transferee firms. The motivation of the transferee firms was to fulfill environmental concerns and derive economic benefits. This ideal combination of motivations was tuned to the spread of technology in this study. The mechanism of licensing, in comparison with other mechanisms such as alliances or joint ventures, seems ideal for technologies of this kind. The active mode of handholding by the physical presence of the scientists while implementing the technology worked well.

The limitation of the research was that the rapid-composing facilities set up by the transferee firms are geographically far away making visits to facilities difficult for interviews. However, this limitation was largely overcome by online video meetings. Future research can include similar studies of societal technologies of other kinds too.

Acknowledgment

We acknowledge the work done by Dr D A Salaskar, in the development of rapid-compostting technology. We thank the Head of Technology Transfer & Collaborative Division, BARC, and his colleagues for providing valuable insights on the tech-transfer procedures they had implemented. We thank Dr Suhas Buddhe, Shri Satish Kharabe, Shri V M Patil, and various other executives of several tech-transferee firms for offering their valuable feedback. We also acknowledge Shri M L Sahu, Shri A K Singh, Dr T R Ganapathi, and Dr Prasun Mukherjee, the previous and current Heads of concerned Divisions in the PMRO for supporting the work.

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