Original Article

Designing an Impact-Oriented Model of Research and Technology Evaluation: An Experience of I.R.Iran

Abstract

Background: Research impact assessment is already being institutionalized in health research and innovation systems. In developing countries, there are many different research assessment models which have focused more on research output in academic levels and less on impact. **Objective:** The aim of this study is designing an Iranian impact-oriented model of research and technology evaluation. **Method:** This is a mixed study. In the quantitative part, by reviewing the literature, a list of research impact indicators that existed were gathered, reviewed, and scored by participants on importance, relevance, and measurability via a 5-point Likert scale. All indicators with a mean score equal to or greater than 3.5 entered the qualitative part, which were discussed in depth by engaging key stakeholders regarding their validity and feasibility through focus groups, interviews, and expert panels. **Results:** The Iranian research impact evaluation model was developed with four main pillars (including input and process, output, outcome, and impact), four areas (stewardship, advancing knowledge and translation, technology, and impact), and 30 indicators through key stakeholders participation in the Iranian health research system. **Conclusions:** This model has been introduced as the first model designed to evaluate the impact of health research and can be one of the most important tools for allocating limited funding resources while maximizing the desired impact of research in the community.

Keywords: *Evaluation, health, impact assessment, research, technology*

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Introduction

The health research system has been considered as a main foundation for obtaining scientific authority, developing technology, and community health problems solving. This system has components including input, process, output, outcome, and impact in a model for quality assessment and systems monitoring. So far, many international ranking systems have been designed to evaluate research and technology activities, which have focused most on research output and in the academic level. The Times Higher Education Supplement [THES],[1] the Academic Ranking of World Universities (ARWU),[2] and the Web Metrics Ranking of World Universities[3] are the most well-known international ranking systems in the output domain. For input evaluation, the only prominent model is the Frascati manual. The Organization for Economic Co-operation and Development (OECD) has been evaluating the financial and human resources (input) of research and development (R and D) since the late 1960s using this manual.[4]

One of the tools for innovation and technology assessment is the Oslo manual. It serves as a guide for collecting and interpreting innovation information. All innovative activities including their scientific, technological, organizational, administrative, and commercial stages have been evaluated by this manual.[5,6] Today, there is a great demand for measuring the impact of research globally. Many advances have been made to measure research output, outcome, and process, but measuring research impact is very challenging.[7]

Research impact occurs when research, in addition to producing an academic knowledge base, also generates benefits in economy, society, culture, public policy or services, national security, health, environment, or quality of life.[8] Research impact is the contribution of research beyond academia[9]; governments, funding agencies, and research organizations are

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interested in maximizing the socioeconomic returns on research investment by shaping policies, decisions, and practices.[10]

Research impact assessment (RIA) is already being institutionalized in health research and innovation systems around the world, such as in Europe, North America, and Australia.[10] Payback, Research Impact Framework, Canadian Academy of Health Sciences, Monetization, Social Impact Assessment, and UK Research Excellence Framework are six established approaches to RIA.[9] RIA is being used as a practical tool for decision making, research resource allocation, and determining accountability to research funders by many research institutes and funding agencies.[11]

In Iran, the Ministry of Health and Medical Education had launched a research activity evaluation system around 20 years ago.[12] In this system, stewardship, capacity building, and knowledge production have been the three main areas of evaluation.[13,14] The number of published articles, books, citations, international collaborations, qualified publications, and also the number of patents are questions that we know the answers to easily, but the impact or benefit of these research works has not yet been formally measured.

In this study, with the participation of key stakeholders, we aim to design the Iranian research evaluation system based on an impact approach and be able to measure the changes caused by research in health promotion, service delivery, and evidence-based decision making.

Materials and Methods

Study design

This study was conducted through two phases, the first taking a quantitative approach and the second taking a qualitative approach. The quantitative phase, where the goal was to identify the key components, characteristics, and indicators in a research impact evaluation model, began with the compilation of a comprehensive list of indicators through a literature review. Expert participants then reviewed this list, scoring each indicator on its importance, relevance, and measurability. In the qualitative phase of the study, through focus groups, interviews, and expert panel discussions, the indicators were discussed in depth regarding their validity and role in a research impact evaluation model. Finally, in order to evaluate the quantitative validity of the indicators, the content validity ratio (CVR) and content validity index (CVI) were determined.

Study participants

Study participants included vice presidents of research and technology in medical universities, policy makers in the field of health science research, and experts in research impact assessment who met the recruitment criteria. The recruitment pool included the following:

a) All vice presidents of research and technology in medical schools/universities in Iran who were working in the position of vice president of research and technology during the duration of the study,
b) Policy makers who have at least 5 years of policy making experience in the field of health science research evaluation, who were selected purposefully, and
c) Experts in RIA (in health sciences or other fields) who were authors of published work in this area (including research papers, books, reports, etc.).

Quantitative approach

The quantitative phase of the study began with a literature review to identify indicators of research impact. The scope of this literature review included the following English-language research databases: Web of Sciences, PubMed, and Scopus. Keywords in this review included “Evaluation”, “Assessment”, “Research Impact”, “Health Research”, “Research Impact Framework”, “Measurement”, “Metrics”, and “Criteria”, with an emphasis on “Health Research Impact”. Papers from 2011 to 2021 were included in this review. In addition, Farsi research databases were included as well, consisting of SID, the Iranian Ministry of Health and Medical Education website, and the Iranian Ministry of Science, Research and Technology website. The inclusion criteria were the proposal of a model or framework with an approach for the evaluation of health research impact.

This review resulted in a set of 168 papers/studies. After reviewing the inclusion criteria, studies with similar models/frameworks and approaches were removed, studies with broader measures were considered and studies on subsets of those measures were removed, and finally papers for the inclusion of which the two researchers leading the literature review were not in agreement were removed. This process narrowed the initial set down to eight models/frameworks which underwent a secondary review. The most frequently cited frameworks including the payback model, expected monetary value, Research Impact Framework [RIF], Research Excellence Framework [REF], logic models, Canadian Academy of Health Sciences model, Research Impact Model, and Persian-language model, the Sanandaj Handbook, were reviewed in depth.

For each of these approaches, the key elements, areas, and indicators relating to the evaluation of research impact were extracted and summarized, and similar and repeated cases in these models were discarded. Finally, the research team held extensive discussions regarding a list of indicators extracted from three models; these included two English-language models, namely, the UK Research Excellence Framework (REF) and the Canadian Academy of Health Sciences Framework (CAHS), and one Persian-language model – the Sanandaj Handbook. The initial checklist included four key elements, six areas, and 61 indicators, which were each then scored by participants on importance, relevance, and measurability on a 5-point Likert scale (with 1 being the lowest and 5 being the highest).

Completing the checklists was done by holding a face-to-face meeting with all vice presidents of research and technology of medical sciences universities, conducting individual interviews with health system policy makers and holding an online meeting with experts in the impact field. In addition, the necessary reminders to complete and send the checklists were made in the form of phone calls or email.

After collecting and analyzing the completed checklists, indicators with a mean score equal to or greater than 3.5 (in at least one of three participant groups) were retained, and the remaining indicators were removed from the model. At this stage, a total of 45 indicators remained, all of which had scored greater than or equal to 3.5 in at least one participant group.

Qualitative approach

In the second phase of the study, an expert panel was held using the Nominal Group Technique, wherein the quantitative results (i.e., the scores of the checklist of indicators for evaluating health research impact) were discussed and examined. The nominal group technique is a face-to-face method to achieve group agreement, and one of its common uses is to reach agreements regarding prioritization.[15] The advantage of this method is that the participants share and discuss all the issues prior to evaluation. Also, each participant participates equally in the evaluation. The participants of this meeting included three representatives from policy maker and expert groups and nine representatives from vice presidents of research and technology (N = 15). The focus group was held at the Research and Technology department of the Iranian Ministry of Health. The total number of sessions was 2, and each session lasted an average of 1 to 1.5 hours. At the start of the session, all the indicators obtained from the quantitative phase of the study were introduced to the participants. The indicators along each axis were examined separately by the participants not only in terms of their technical performance in the model but also in terms of wording and clarity. This resulted in the necessary corrections being made by participants, including certain indicators being renamed, added, or removed.

Content validation

Next, the checklist of indicators was sent to 15 experts of the health-related research system to determine the content validity quantitatively. In order to determine the CVR based on the Lawshe method, each index was scored in terms of necessity via a 3-point Likert scale (essential, useful, but not essential, or not necessary).[16] To check the CVI based on the Waltz and Basel method, each indicator is scored in terms of relevance, clarity, and simplicity based on a 4-point Likert scale.[17] The minimum acceptable value of CVR for 15 experts is 0.7, and for CVI, it is 0.79.[18]

Research steps

This study had five steps as follows:
- Extracting the research impact indicators via literature review on foreign and domestic databases
- Scoring the extracted research impact indicators based on importance, relevance, and measurability via a 5-point Likert scale by study participants (primitive screening)
- Holding expert panels by the nominal group method to technical review of model indicators (secondary screening)
- Content validation study by CVR and CVI calculation
- Introduction of the validated research impact evaluation model [Figure 1].

Results

In order to develop a comprehensive evaluation model of research and technology with an impact approach, the areas and main evaluation components resulting from the review of the literature were scored by vice presidents of research and technology of universities, policy makers, and impact experts in terms of importance, necessity, and measurability. The demographic characteristics of the participants are listed in Table 1.

Based on the literature review, six main fields and 61 indicators were extracted [Table 2]. The main areas included advancing knowledge (13 indicators), building capacity (11 indicators), informing decision making (17 indicators), broad socioeconomic impact (9 indicators), environment (7 indicators), and health impact (4 indicators). After analyzing the collected checklists, 45 components received an average score above 3.5 from at least one of the participant groups. After holding a meeting of experts and carrying out the nominal group technique, seven indicators named “One year citations”, “Relative download rate”, “Consulting to industry”, “Clustering co location”, “Citations in public policy documents”, “Consulting to policy”, and “Level of social isolation” were removed and two indicators called “Impact on social determinants of health” and “Impact on environmental determinants” were

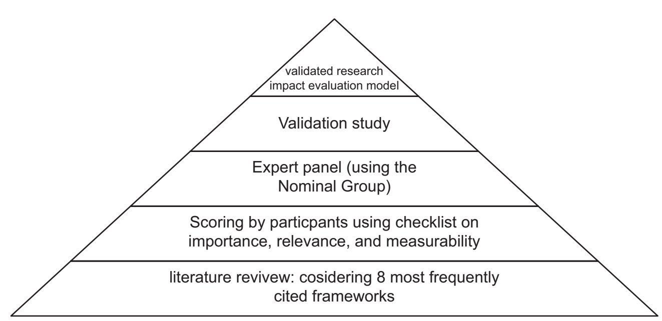

Figure 1: Phases in developing the research impact evaluation mode

Table 1: Study participants' demographic characteristics

Study participants	Number	Mean age (year)	Activity (year)	Sex
Deputies for research and technology of universities of medical sciences	58	52.3	1.7	Male=50
Policy makers	5	69.2	10.4	Male=5
Experts in research impact	5	38.5	6.7	Male=4

merged due to overlapping content, and the remaining 37 indicators entered the validation study. The demographic characteristics of the participants in the qualitative phase are listed in Table 3. At this stage, 30 indicators had CVI and CVR higher than 0.79 and 0.7, respectively, which remained in the model, and seven indicators named "Relative activity index", "Expanded relative citation impact", "Health benefit in QALYs per health care dollar", "effect on happiness", "Collaboration and contribution to the research base, economy and society", "Research training", and "Research productivity", which had CVR and CVI lower than 0.7 and 0.79, were removed from the model. Finally, the research impact evaluation model was finalized with four pillars (input and process, output, outcome, impact), four areas (stewardship, advancing knowledge and translation, technology, and impact) and 30 indicators [Table 4].

Discussion

This research impact evaluation model was developed with four main pillars (including input and process, output, outcome, and impact), four areas (stewardship, advancing knowledge and translation, technology, and impact), and 30 indicators approved by the primary stakeholders in the Iranian health research system. A unique feature of this model is its systemic perspective starting internally and achieving short-term, medium-term, and long-term outcomes according to the goals of the health research system. In fact, by understanding the pillars and indicators of this model, it is possible to create a research pathway from the study design to achieving the desired impact, objectively assessing the dimensions of suitability, efficiency, effectiveness, and usefulness.

The literature review shows that one of the reputable methods for research evaluation is the Research Excellence Framework (REF), which is used in higher education institutes in the UK to evaluate their quality of research. The main evaluation axes in this framework include human resources, research output, research impact and application, and research infrastructure and environment.[19] Comparing the results of our study with the REF shows that there are shared indicators between the models as well as some differences. While research effectiveness and research environment play a key role in both models, our (Iranian) model places a greater emphasis on technology. Comparing this Iranian model with the Canadian Academy of Health Sciences (CAHS) framework also shows similarities and differences. The CAHS framework consists of five main categories including knowledge advancement, empowerment, policy making, the impact on health, and the impact on socioeconomic circumstances. In contrast, the Iranian model does not include the category of empowerment and additionally includes categories for input and technology in addition to knowledge advancement and impact.

Evaluation using the CAHS framework relies on 66 indicators and is backed by databases and information collected at individual, institutional, regional, national, and international levels.[20] Meanwhile in the Iranian model, it is not possible to evaluate the impact on a wide scale and at different levels (national, regional, institutional, and individual) due to the lack of data, processes, and appropriate monitoring systems.

A fundamental strength of the Iranian model is the combination of qualitative and quantitative indicators. Existing research impact evaluation models focus on quantitative indicators such as the number of publications, journal impact indices, and citations.[21] This is reflective of the belief that results obtained from these quantitative indicators are highly accurate, quickly obtained, accessible, and more useful for financial support and decision making.[22] These models emphasize high publication numbers, especially at the international level; they suggest that an increase in publications can lead to changes in the health of a community. Meanwhile, others believe that these indicators only evaluate the initial values of research output, which ultimately leads to academic growth.[23] Quantitative indicators in impact measurement do not necessarily express the complexity of the relationships involved in research and may exclude the evaluation of specific dimensions of the research process.[24] Evaluating the research impact using qualitative measures, considering important socioeconomic shifts, can not only provide funders with a clear and meaningful picture of the return on their investments but also guide the direction of researchers' efforts. Past experiences of evaluating the country's health research have informed the combined use of quantitative evaluation using scientometric indicators and qualitative evaluation using impact indicators within the evaluation scope of the medical science research institutes.[25]

Another prominent feature of the research and technology impact evaluation model is the involvement of research stakeholders, including researchers, government organizations, funding agencies, the industry sector, and health policymakers. This model, with emphasis on the importance of communication between researchers and stakeholders as the key element in achieving

Table 2: Main field, subfield, and description of primitive indicators based on review literature

Main field	Indicator	Description	Mean
Advancing knowledge	Publication count	The number of publications indexed in ISI web of science, PubMed, and Scopus databases	3.82
	High-quality Publication	Number of articles published in the first quartile (Q1) of scientific journals in Scopus	4.18
	Research international cooperation	The number of articles with international collaborations	4.25
	Highly cited publication	The number of hot paper and highly cited paper indexed in ISI web of science	4.16
	Field-weighted citation impact	Average citations received compared to the global citation rate in the same discipline	3.57
	Field analysis of citations	Number of citations to articles by field	3.21
	Relative activity index**	Determining the research line	3.82
	Expanded relative citation impact**	The number of citations in other publications such as reference books	3.58
	One year citations*	The number of citations to published articles which indexed to Scopus in the same year	3.78
	Five year h index	H index value for articles published in last 5 years in Scopus	3.52
	Total citation to five years articles	The number of citations to total published articles indexed in Scopus in the last 5 years	3.64
	Paper to academic member	Paper to academic member	4.36
	Relative download rate*	Average number of article downloads	3.58
Building capacity	Research diffusion	List of users of research results	2.33
	Numbers of research and research related staff	Number of academic member in universities of medical sciences	4 .25
	Infrastructure grants	Financial attraction to strengthen the infrastructure	3.71
	Levels of additional research funding	Financial attraction for empowerment	3.34
	Absorptive capacity	Ability of researchers to attract and conduct research outside the center	3.11
	Graduated students in health related subjects	The number of students in postgraduate studies related to health research	3.42
	Receptor capacity	The policy maker's ability to use research results	3.11
	% of activity grants with infrastructure support	The ratio of the grants received for infrastructure support to the total grants received	2.56
	Research infrastructure	Points obtained from the research structures of medical sciences universities such as laboratories, registration programs, student research committees, and population studies	4.23
	Technology infrastructure	Points obtained from the technology structures of universities of medical sciences	4.32
	Collaboration with industry	Number of contracts concluded between university and industry	4.63
Informing decision-making	Patent number	Number of patents licensed	4.64
	Consulting to industry*	Number of consultations given to industry	3.59
	Research utilization in policy making	Number of research-based decisions in public health policy makers	4.23
	Use of research in guidelines	Number of citations to research in health services or clinical guidelines	3.41
	Research used in curricula for new researchers	The number of citations to research in textbooks and study resources of university students in health-related fields	2.56
	Production of educational materials using research	The number of research cited in ongoing health professional education material	3.24
	Requests for research to support policy	The number of requests by policymakers to conduct research: a systematic review	4.21
	Clustering co location*	Analysis of industry position in research centers	3.65
	Citations in public policy documents*	Number of citations to research done in decision making documents	3.67
	Use of research in guidelines	Number of citations to research in guidelines	3.62
	Use of research in stage reports by industry	The number of citations to the research conducted in industry sector reports	2.89

Contd...

Table 2: Contd...

Main field	Indicator	Description	Mean
	Media citation analysis	Number of presentations of research results in the media	3.57
	Public lectures given	Number of speeches in public meetings	2.45
	Utilization of research findings outside health	Number of utilized of published research results by other disciplines outside of health	3.22
	Consulting to policy*	The number of consultations given to the policy maker	3.56
	Research cited in advocacy publications	Number of citations to research in advocacy publications, such as references to research in brochures published by patient advocacy groups	3.24
	Citation analysis of successful funding applications	Identifying the number of studies that have been cited in successful funding programs.	2.96
Broad socio-economic impacts	Product sales revenues	Income from the sale of research products in million Rials	3.98
	Licensing returns	Income from the sale of inventions in million Rials	4.23
	Research products	The number of research product	3.67
	Valuation of spinout companies	Financial value of new spin out companies in million rials	3.56
	Economic rent (Labor rents)	Economic benefits of employing people in health research and not in any other capacity	4.78
	Health benefit in QALYs per health care dollar**	Financial value of health effects through QALY improvement	3.67
	effect on happiness**	Change on happiness in society	3.99
	Health benefit in PROMs per health care	Financial value of health impact through PROM improvement	2.35
	Level of social isolation*	The effect of research on the level of social isolation	3.67
Environment	Strategic planning	Existence of strategic planning in universities of medical sciences	4.67
	Research priorities	Existence of research priorities list	4.34
	Ethics	Points obtained from ethics committees in research of medical sciences universities	3.87
	Collaboration and contribution to the research base, economy and society**	The number of cases of cooperation with economy, industry and society	3.87
	Cooperation with research institutions	The number of cases of cooperation with research institutions	3.67
	Research training**	The number of cases of teaching research to students in the form of some programs such as PhD by research	4.12
	Research productivity**	Productivity in terms of: budget, manpower, physical space, equipment	4.32
Health impact	Impact on health status	Changes in prevalence, incidence, mortality, YLD, etc.	3.69
	Impact on social determinants of health***	Changes in on social determinants of health	3.78
	Impact on health services	Improving service delivery by changing the level of satisfaction, accessibility, appropriateness, continuity, effectiveness, efficiency and safety	4.21
	Impact on environmental determinants***	Changes in on environmental determinants of health	3.78

Underline: Remove in primitive screening, *Remove in secondary screening, **Remove in validation study, *** Merging the indicators

research impact, tries to determine collaborative and cooperative processes in addition to defining the role of each stakeholder. Increasing communication between stakeholders and creating a common language and theory in determining the research path (e.g., identifying needs and setting priorities, designing proposals, funding, and research implementation) has a considerable effect on achieving research impact and creating meaningful change in the health of the community.[20] The intersection and interaction of science and society has been emphasized as one of the main pillars in evaluation systems established in recent years (Science-Society). This results not only in the production of evidence-based knowledge but also in the creation of transparent and collaborative knowledge characterized by the collaboration of researchers with stakeholders.[26] In general, the most important practical benefit of this model is directing research institutions to solve the problems of the health system.

In this evaluation mode, there are several challenges when determining the impact of research on changes created in health systems. One of the most important challenges is time lag; in some cases, it takes years for research findings to result in changes in the community.[27] Additionally, though a single study may not directly result in change, a combination of multiple studies, organizations, and individuals may create change in a way that makes evaluation complicated. The retrospective nature of the impact evaluation process poses a challenge as in many cases, the records are no longer available or are not possible to access (e.g., due to

Table 3: Study participants' demographic characteristics

Study participants	Number	Mean age (year)	Activity (year)	Sex
Deputies for research and technology of universities of medical sciences	9*	48.8	2.3	Male=6
Policy makers	3	65.2	9.4	Male=3
Experts in research impact	3	37.4	6.7	Male=2

*Three from each type of university

Table 4: Research impact evaluation model of research and technology

Pillar	Area	Indicator
Input & Process	Stewardship	Strategic planning
		Research priorities
		Ethics
		Research infrastructure
		Technology infrastructure
		Numbers of research and research related staff
		Cooperation with research institutions
		Infrastructure grants
Output	Advancing knowledge and Translation	Publication count
		High-quality Publication
		Research international cooperation
		Highly cited publication
		Field weighted citation impact
		Five year h index
		Total citation to five years articles
		Paper to academic member
		Media citation analysis
		Requests for research to support policy
		Use of research in guidelines
Outcome	Technology	Collaboration with industry
		Patent number
		Licensing returns
		Product sales revenues
		Valuation of spinout companies
		Research products
		Economic rent (Labor rents)
Impact	Impact	Impact on health status
		Impact on social determinants of health
		Impact on health services
		Impact on policy making

changes in management, record keeping systems, etc.). In some models, a prospective approach is recommended for evaluating research impact based on predictors such as the involvement of stakeholders in the initial stages of research implementation and defining what the impact is and how to achieve it. In these models, the collaboration process of researchers and stakeholders is evaluated. In any case, the time-consuming and costly nature of this process is shared by all research impact evaluation models.

Conclusions

Research impact evaluation can be one of the most important tools for optimally allocating limited funding resources while maximizing the desired impact of research in the community. This research impact evaluation model is introduced as the first model designed to evaluate the impact of health research in Iran. To improve the quality of research in the field of health and to create an approach for the use of research findings, it is necessary to implement a single comprehensive mode.

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Conflicts of interest

There are no conflicts of interest.

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