Factor Analysis based on ABCD Framework on Recently Announced New Research Indices

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ABSTRACT

Research indices are used to measure the ability of a researcher and quality of research publications for comparison of research contribution made in a given area/subject. Research indices generally use the number of research publications and the number of citations the papers published by an author during a given observation period. There are a number of research indices commonly used to assess the ability and hence the quantity of research along with the quality of a research publication. Research indices are calculated based on either citation values of research publications of a research scholar or the number of research papers published by a research scholar for a given period. Apart from generally used citation indices like H-index, i10-index, G-index, and based on argument on why certain research publications do not attract citations initially for some years, it is found that the best method of identifying the contribution to research is calculating the annual research index for an author by considering the annual research publications. Recently, we have suggested some of the new research indices used for calculating research productivity of individuals as well as a team of people in an organization which include ARP-Index – (Annual Research Publication Index), RC-Index – (Research Continuation Index), RE-Index (Research expansion Index), Project Productivity Index, and Cost Index. In this paper, we have analysed the affecting factors on these indices by considering four determinant issues which include research organization, researcher, funding agency, and industry using objectives, productivity, and cost as three key parameters. The various factors affecting these newly proposed research indices are discussed by considering their advantages, benefits, constraints, and disadvantages.

Keywords: Factor analysis**,** ABCD analysis framework, Research indices, ARP-Index, RC-Index, RE-Index, Project Productivity Index, Cost per paper Index.

1. INTRODUCTION :

Research indices are used to measure the ability of a researcher and quality of research publications for comparison of research contribution made in a given area/subject. Research index of a research paper is calculated based on number of citations the research paper received. The research index of a research scholar is calculated based on the number of research papers published by that research scholar for a given period. There are many research indices developed by many researchers which include H-, i10-, G-, H(2)-, HG-, Q2-, AR-, M-quotient, M-, W-, Hw-, E-, A-, R-, W-, J-index, etc. [6]. Out of these citation-based research indices, h-index, G-index and i10-index are commonly used in some of the Citation databases [1-3]. The citation based research indices calculated on of a paper or number of papers of an author has both merits and demerits. The citation index may be less for good paper or papers of an author due to following reasons [3-4]:

(1) The research paper topic may be unique and only a few people/groups are doing research on that topic.

(2) The paper may not easily available for

publics download in the journal website (not open access journal), in various databases, or due to copyright transfer from author to published journal.
(3) The research paper might have completed the entire issue of the research and no further research in that topic might be possible.
(4) Some general papers in emerging field, review papers on various futuristic field are able to attract more citations compared to a paper in a new field.
(5) If a research paper has ability to attract others and opens further new opportunities for research, it naturally motivates new research in same area or related areas.

2. NEW RESEARCH INDICES PRO POSED :

The research indices discussed above are calculated based on a number of citations a paper receives. The major limitation of this model is that the citations usually increase with an increase in time even after the researcher dies. Hence the indices continue to grow. It is argued that due to various reasons, a research publication may not attract citations initially for some years and after ten to twenty years some papers may attract citations. The best method of identifying the contribution to research is calculating the annual research index for an author by considering the annual research publications. Accordingly, based on annual research index of an author, his average research contribution for five years, or ten years, or twenty years or any desired period can be determined. Recently, we have suggested some of the new research indices used for calculating research productivity of individuals as well as a team of people in an organization which include ARP-Index – (Annual Research Publication Index), RC-Index – (Research Continuation Index), RE-Index (Research Expansion Index), Project Productivity Index, and Cost Index [4-5]. In this paper, we have analysed the affecting factors on these indices by considering four determinant issues which include research organization, researcher, funding agency, and industry using objectives, productivity, and cost as three key parameters. The various factors affecting these newly proposed research indices are discussed by considering their advantages, benefits, constraints, and disadvantages.

3. ABCD ANALYSIS FRAMEWORK :

To address the above mentioned constraints of citation indices, it is argued that the best method of identifying the contribution to research is calculating the annual research index for an author by considering the annual research publications. Accordingly, based on annual research index of an author, his average research contribution for five years, or ten years, or twenty years or any desired period can be determined. Recently, we have suggested some of the new indices to be used for calculating research productivity of individuals as well as a team of people in an organization. In this section, we have analysed the advantages, benefits, constraints, and disadvantages of these indices using our own developed ABCD analysis/listing framework [6- 17].
ABCD analysis framework [18] is suitable for analysing business concepts, business systems, technology, business models or business idea in terms of determining various factors for chosen determinant issues under four constructs called advantages, benefits, constraints, and disadvantages. In the qualitative analysis using ABCD framework, the concept/system/ strategy/technology/ model/idea is further analysed by identifying constitutional critical factors. In the quantitative analysis using ABCD framework [19], the appropriate score/weightage is given to each constituent critical factor under each construct, through empirical research, the total score is calculated for each construct and by evaluating the scores, the concept/idea/system/ technology/strategy can be accepted or rejected.
Thus ABCD analysis framework can be used as a research tool in these areas and is a simple but systematic analyzing technique for business models/systems/ concepts/ideas /technology/ strategy analysis [19]. ABCD analysis is used for analysis of various concepts (1) Working from Home - a e-business model [20], (2) Black ocean strategy [21], (3) Higher Education Stage Model [22], (3) National Assessment and Accreditation Council (NAAC) accreditation process [23], (4) Private University System in India [24], (5) Study of New National Institutional Ranking

Framework (NIRF) System [25], (6) ABC organizational research performance model [26], (7) Elemental and factor analysis of the usage of dye-doped polymer films for photonic applications [27], (8) Online Industry Oriented Campus (OIOC) Placement Model [28], (9) Six thinking hats model for lateral thinking [29], (10) Analysis of 'Theory A' on Organizational Performance [30], etc.

4. FACTORS AFFECTING THE PROPOSED RESEARCH INDICES :

A systematic analysing technique devised by Aithal P. S. et. al. [18] for analyzing any system in an organized list of a business Advantages, Benefits, Constraints, and Disadvantages in a systematic matrix is called ABCD framework. The entire framework is divided into various identified determinant issues and various key issues affecting the model and analyzed under affecting factors and further derived suitable critical effective elements. This analyzing technique being simple gives a guideline to identify and analyze the effectiveness of any concept/idea, and system. Here, we have used ABCD analysis framework to identify the factors affecting on the newly announced research indices.

(1) ARP-Index – (Annual Research Publication Index):

The number of research publications of a researcher during a given period shows his/her active participation in research. In the era of publish or perish, if researcher fails to publish research papers by setting the target, they cannot compete with others in the race. Annual Research Publication index (ARP-index) is based on the annual research productivity of an author, or group of authors, or a research organization [31]. ARP index gives the weighted average of publications for a given year as the time period. This index will give annual research performance of any year (or any specific time period) of an author without considering the citations by considering the fact that usually the citations for a paper takes a long time and is variable quantity with time. This index is more useful for quick comparison of many researchers working in same or related fields for a given period of observation. This index will also stimulate the researchers to set the target for a given time period through proper planning to improve their annual research productivity. ARP-index makes use of ABC model of research productivity [31-38]. It is the weighted average of scholar's annual publications. The ARP index is exactly equal to annual research index (α) of a given person.

ARP-index = annual research index (α) = [(2A + 5B + 1C)/8], where A is number of Articles published in refereed ISSN numbered journals during a given year, B is number of Books published with an ISBN number during a given year, and C is number of book Chapters or Case studies published with DOI during a given year. The ARP index can be calculated for a researcher, for a group of researchers/department or for a given organization. For a group of researchers/ department or for a given organization, ARP-index can be calculated by considering a number of researchers (N) in the group or in that organization. Then ARP-index becomes [(2A + 5B + 1C)/8]/N. ARP-index can be used to compare researchers annual productivity for a given time period and the annual research output of higher education and research organizations.

ABCD Factor Analysis of ARP Index :

The various determinant issues affecting the ABC model of annual research productivity of an organization include Organizational issues, Academic & Curriculum Issues, Faculty Issues, Students Issues, and Other Stakeholders Issues. Each determinant issue has sub-issues called key parameters/properties used for analyzing the advantages, benefits, constraints and disadvantages, the four constructs of the framework. The key parameters for ABCD constructs in case of the ABC model of organizational research performance are Research, Ranking, Perception, and Utility. The factors affecting the various determinant issues of the ARP-index for each key parameters under four constructs are derived by a qualitative data collection instrument namely, focus group method [39] and are listed in table 1.

Table 1 : Factor analysis of Annual Research Productivity (ARP)-index using ABCD framework

Determinant Issues	Key Parameters	Advantages	Benefits	Constraints	Disadvantages
Research Organization	Objective	Research focus	Brand	Leadership	Low profit
	Productivity	Improvement	Enhanced publications	Faculty motivation	High pressure
	Fund	Optimization	Annual Budget	Allocating Research Fund	Pressure on cost Reduction
Researcher	Objective	Focus on Research	Promotion	Time	Procrastination
	Productivity	Enhanced Research output	Publications	Team work	Reward
	Fund	Institutional support	Cost optimization	Resource gathering	Utilization
Funding Agency	Objective	Research support	New knowledge	Limited resource	Mis-utilization
	Productivity	More Research	More publications and patents	Funding amount	Low calibre researchers
	Fund	Annual allocation	Enhanced annual productivity	Annual accounting	Low yield due to annual auditing
Industry	Objective	More innovative research	New or improved technology & processes	Follow-up	Low industry institute interactions
	Productivity	Enhanced research involvement	Quick growth	Slow technology transfer	Relevancy of research output
	Fund	Opportunity to invest on research	Research investment for quick return	Procedure to get industry fund	Satisfying the industry

(2) RC-Index – (Research Continuation Index) :

Research continuation index encourages self-citation. As per the general definition, self-citation is a process of citing some of the old published papers of the same authors in present paper if they are relevant and appropriate to mention in the reference. This self-citation of related works will avoid repetition of concepts and even avoids self-plagiarism. Authors working in a unique area as monopoly researchers will not find much-published work by others in current research area/topic may find only their previous works as relevant to quote in the introduction as well as in literature review. Thus depending on the research topic in hand, an author can cite any published article whoever's it may be as cited article including self-citation. Thinking honestly, self-citation has nothing to do with ethics of publication until it cites relevant work and adds the weightage of current publication. Thus self-citation indicates *research continuation* in a given field by a given researcher or team of researchers. Accordingly, we have developed a new research index called Research Continuation index (RC-Index). RC index is planned to consider both the number of publications for a given time period and the number of self-citation of previous articles in the publications so that one can have an idea of research continuation responsibility of an author or group of researchers or a research institution.

Accordingly, RC-index is defined as the product of the number of research publications during a given period and the number of self-citations in those published papers.

RC-index = (Number of journal publications × Number of self-citations in those papers) = (n × m), where n = number of journal publications of the researcher during a given period (maybe annually) and m = Number of self-citations in those papers during the same period.

Research Continuation index assumes that any new research work publication if it is a continuation of previous research work or the continuation of previous research topic will contain by logically the self-citation of previous works and publications. If self-citation is zero, means the researcher is not continued his previous work/works. RC-index indicates the magnitude of activeness of researcher by his number of publications during a given period and ability of continuation of previous research topic/topics by a number of his self-citations. RC-index can be increased by a researcher by increasing his research contribution as well as effective self-citation during a given period.

ABCD Factor Analysis of RC-Index:

The factors affecting the various determinant issues of the RC-index for each key parameters under four constructs are derived by focus group method are listed in table 2.

Table 2: Factor analysis of Research Continuation (RC)-index using ABCD framework

Determinant Issues	Key Parameters	Advantages	Benefits	Constraints	Disadvantages
Research Organization	Objective	Interrelated new investigation	Growth of a research topic	Continuation of funding for a single project	Enhanced Self-citation
	Productivity	Increases in terms of number of publications and citations	Brand & Ranking	Continuation of research in a single field is difficult	Self-citation is not counted in some citation indices
	Cost	Continuation of research is less costly	More research output at low funding	Continued funding is difficult	Research Breakthrough is difficult
Researcher	Objective	Continuation of research leads specialization	Researcher becomes authority in that field	Limited specialization	Limited collaborators
	Productivity	High	Enhanced number of publications & citations	Self-citation is essential in continuation research	Publications in reputed journals is difficult
	Cost	Low fund requirement for continuation	Low cost per paper publication	Difficult to attract new funds	Organizational research always focus on new area
Funding Agency	Objective	Encourages continuation of research	More productivity at low funding cost	New research are also encouraged	Multiple funding to a given
	Productivity	Continued research increases productivity	Increased return on investment	Less number of research fields	Low patent yield
	Cost	Low	Less	Less	Continued

		investment	expenditure	breakthroughs & patents	funding to a single research organization
Industry	Objective	Systematic & focussed research	More opportunities in a single area due to continued research	Less wider scope	Less variety topics
	Productivity	Focussed information in a chosen topic	Supports innovative processes	Commercialization of research	Focus is on single topic
	Cost	Low cost	Industry support	Continuous improvement	Reduced industry investment

(3) RE-Index (Research expansion Index) :

Contrary to research continuation index (RC-index), a researcher can determine his research expansion index by knowing a number of journal publications and number of external citations during a given observation period.

RE-index = (Number of Individual publications × Number of Citations on those papers by other researchers) during a given observation period.

RE-index indicates how the research topics studied by the researcher have expanded to other researchers so that they also started to work on those topics and published papers by citing the initial researcher's papers in their publications. RE-index gives equal importance on Number of publications by an author (n) and number of citations by others (p) on theses papers during a given observation time. RE-index gives an idea of how quickly others have picked up the idea/research work of a particular researcher and continued research on that topic.

ABCD Factor Analysis of RE-Index :

The factors affecting the various determinant issues of the Research Expansion (RE)-index for each key parameter under four constructs are derived by focus group method are listed in table 3.

Table 3: Factor analysis of RE-index using ABCD framework

Determinant Issues	Key Property	Advantages	Benefits	Constraints	Disadvantages
Research Organization	Objective	Involvement by many groups	More research output	Less focus	Discourages self-citation
	Productivity	Increases	Increased citations	Self-citations are not accounted	Discourage for continued research
	Cost	Moderate cost	Increased branding	Cost spreading	Increased cost
Researcher	Objective	Expansion to other fields	Varity of publications	Wide Publications reachability	Opportunity loss due to sharing of research topic
	Productivity	More research on same topic	Enhanced citations	Fragmented results	Lose of monopoly
	Cost	Popularity based	Enhanced funding &	Lost monopoly in project cost	Repetition of research facility

		funding	spreaded cost		in many organizations
Funding Agency	Objective	More Publications	More citations	Commercialization	Enhanced expenditure
	Productivity	More research through expansion	Enhanced productivity	Enhanced demand for funding	Shared productivity
	Cost	Increased request for funding	Increased demand for funding	Fund constraint	Control of fund utilization
Industry	Objective	New area Research	New opportunity to do business	More investment	Risk
	Productivity	Enhanced Productivity	More publications	Quality research	Enhanced investment
	Cost	Increased cost	More research teams	Cost control	Repetition

(4) Project Productivity Index (PP-index) :

Many organizations do research by involving their researchers to work in externally funded projects as well as internally funded projects. Externally funded projects are given by Country government, various research agencies, or different industries. Internally funded projects are offered to researchers based on their department and on individual topics. The productivity of such project can be calculated by studying the number of research publication created/patents obtained from such projects. For such scenario, the funding agency can measure the productivity of a project using a quantity called project productivity index (PP-index). PP-index is defined as a ratio of Research productivity to Project funding. Research productivity can be measured by knowing the number of papers published or number of patents obtained from that project.

If n is the number of journal papers published or/and patents accepted and A is the amount in Rs./$ spent for completion of a research project, then PP-index = (n/A). By increasing the number of publications from a project or by decreasing the expenditure of a research project, one can increase the Project productivity index. Using this index, one can determine the total cost per publication in a given project and hence the success or failure of the project can be judged.

PP-index = (Research Productivity / Project Funding) = (1/Cost per publication)

ABCD Factor Analysis of PP-index :

The factors affecting the various determinant issues of the PP-index for each key parameters under four constructs are derived by focus group method are listed in table 4.

Table 4: Factor analysis of Project Productivity (PP)-index using ABCD framework

Determinant Issues	Key Parameters	Advantages	Benefits	Constraints	Disadvantages
Research Organization	Objective	Increase in Productivity	Decrease in cost	Cost control	High cost projects
	Productivity	Motivation for productivity	Motivation for cost control	Pressure on improving productivity	Controlling the cost while increasing the productivity
	Cost	Control of cost	Decreased investment	Controlling indirect cost	Low productivity or high cost

Researcher	Objective	More research	Cost reduction	More publications	More time consumption
	Productivity	Pressure on productivity	Control on cost	Heavy pressure	Optimizing the index value
	Cost	Focus on decreasing	Decreased investment	Effort on cost reduction	Increased cost for increased productivity
Funding Agency	Objective	Higher output	Lower funding cost	Increasing the index	Enhanced funding requirement for costly project
	Productivity	Directly dependent on PP-index	Indirectly proportional to cost reduction	Low fund for low productivity	No fund for no productivity
	Cost	Index value depends on cost	More productivity at low funding	Low productivity discourages funding	High cost stops funding
Industry	Objective	High research productivity	New model, process, or technology	Cost control	Decreased productivity
	Productivity	Higher PP index for higher productivity	Higher PP index for lower cost	Boosting productivity	Increased cost due to boosting productivity
	Cost	Control	Low investment for new knowledge	Technology transfer	Long time for commercialization

(5) Cost per Paper Index (CPP-Index):

CPP-index includes both, the cost of research and the cost of publication. Cost of the research include the cost of writing the project by gathering information and literature, cost of availing and setting up experimental setup or empirical methodology, cost of various resources used for research, cost of gathering data, analysing them and interpreting the result, Cost of writing research publication papers and patents, cost of publication fee/article processing charge for creative commons publications etc. Depending on the ability of the researcher and depending on the research methodology used for the research, the cost of research varies. The cost per paper index is a new way of seeing the research expenditure as an investment to get better output. Generally, the cost of research increases from conceptual research to theoretical research, to empirical research, to experimental research. A researcher should plan how to decrease the cost of research even if he is supported by government or public sector funding agencies due to the fact that such money is from the taxpayers of the country. Thus every research organization should seriously think on the output of every research project carried out by its researchers through a measuring scale using cost per paper index. Cost per paper/patent index gives a fair idea on the average cost of each paper publication which is the output of a research project under completion. Both research organization and researcher should plan how to decrease average cost per paper without compromising the quality. Generally based on prediction, cost per paper is lowest for conceptual based papers and highest for experiment based papers. Some experiments need huge investment on machines, technology, and materials. But such experiments should be planned to get a good amount of output. Thus while planning for investment on research; organizations should target to decrease the cost per paper/patent to increase the productivity. Ideally, the cost per research paper including publication should be

zero for good research and in all practical cases it should be as low as possible.

ABCD Factor Analysis of CPP-index:

Similarly, the factors affecting the various determinant issues of the CPP-index for each key parameter under four constructs are derived by focus group method are listed in table 5.

Table 5: Factor analysis of Cost per Paper (CPP)-index using ABCD framework

Determinant Issues	Key Parameters	Advantages	Benefits	Constraints	Disadvantages
Research Organization	Objective	Low	Less investment	Cost control	Focus on low cost research
	Productivity	High	More research	Struggle to more publications	Focus on low cost research
	Cost	More papers	Improved research output	Compromise in quality	Heavy pressure on researcher
Researcher	Objective	More research	More publications	Time management	Compromise in quality
	Productivity	Increase in Publications	Decreases the cost per paper	Increase in productivity	Decrease in cost decreases productivity
	Cost	Should be low	Low budget	Controlling the cost	Attracting high cost projects
Funding Agency	Objective	High yield at low fund	Better return on funding investment	Identifying the projects	More funding requests
	Productivity	Encouragement	More publications	Choosing the projects	High index value
	Cost	Low funding	Low budget requirement	Identifying low cost projects	Increase in cost of the project decreases the index value
Industry	Objective	New knowledge	Use of knowledge for progress	Industry participation for research	Less support from Research
	Productivity	More knowledge	Increased productivity	New research effect on productivity	Enhancing productivity at low cost
	Cost	Low cost	New knowledge at low cost	Knowledge transfer at low cost	Expenditure for commercialization of research output

5. Conclusion :

The new research indices proposed are useful for measuring the research performance of the researchers, organizations, and other stakeholders. The value of research index based on various research parameters is expected to boost the self-motivation of researchers working in any area. The popular research indices like h-index, i-10 index, g-index, R-index, m-index etc. have their own advantages, benefits, constraints, and disadvantages as listed in previous paper [5]. In this paper, we have studied the ABCD framework based analysis of recently developed research indices. The factors affecting under various determinant issues and under identified key factors are identified under the constructs advantages, benefits, constraints, and disadvantages of calculating the annual research index (ARP-index) for an author by considering the annual research publications are studied. Accordingly, based on annual research index of

an author, his average research contribution for five years, or ten years, or twenty years or any desired period can be determined. Similarly, The factors affecting under various determinant issues and under identified key factors are identified under the constructs advantages, benefits, constraints, and disadvantages of calculating the research Continuation Index (RC-Index) of an author is studied by considering the annual self citation are identified and discussed. The advantages, benefits, constraints, and disadvantages of calculating the Research expansion Index (RE-Index) of an author are studied by considering the annual external citation are identified and discussed. The advantages, benefits, constraints, and disadvantages of calculating the Project Productivity Index, and Cost per paper Index are also identified and discussed. It is found that these new indices are effective and simple in the research output of an organization. The detailed analysis of the factors affecting these indices using ABCD analysis framework are presented in this paper.

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