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Heuristics and Prospect Theories on Investors' Decision-Making Process: Concepts and Research in the Global Context

Joy Chakraborty[1]

Abstract

Behavioural finance theories hold an edge over traditional finance theories as the former includes the psychological factors involved in an investor's decision-making process. Traditional finance theories advocate human beings as rational, while behavioural finance theories depict irregular and irrational behaviour of investors in making investment decisions. The application of behavioural finance rests on two principles of cognitive illusion, namely the heuristics theory and prospect theory, that explain the various biases found in an investor's behaviour in making financial decisions. The present study attempts to provide insight into two main behavioural finance theories (Heuristics and Prospects) and their implications on the investment performance of individual investors. Before investing, many factors come to an investor's mind which may regulate the decisions related to investments. This paper primarily contributes to the field of behavioural finance which explains an investor's irrational behaviour as the outcome of certain cognitive and/or emotional biases in their thought process.

Keywords: Behavioural Finance, Heuristics, Prospect Theories, Cognitive Bias.

1. Introduction

The field of finance during the second half of the twentieth century was dominated by the principles of traditional finance. The traditional model of finance assumes that investors are rational. The efficient market hypothesis, under the domain of traditional finance, states that at a single point in time, the price of all assets and securities being traded in the market is a perfect portrayal of all the information that is available. But later on, psychologists found the irregular behaviour of investors in making investment decisions, and they were the first to challenge the

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conventional models of standard finance. It came to the limelight that investors' emotional bias and cognitive errors often lead to making poor investment decisions. Though at the beginning, finance experts were not ready to accept the views of psychologists, but economist Vernon Smith and psychologist Daniel Kahneman first proved the significance of behavioural finance by winning the Nobel Prize in the year 2002. Since then, financial experts started believing that human brains go through various emotional layers while making investment decisions (Hirschey and Nofsinger, 2008).

From time immemorial, theories of economics and finance have mainly focused on models that talk about rationality, but behavioural finance emerged as a new domain that tries to explain the factors that affect individuals' investment decisions. The subject combines various cognitive, psychological, and behavioural aspects with traditional theories of finance and economics. Where traditional finance theories fail to explain the expected utility of rational investors, behavioural finance has proven its significance by way of understanding the behavioural traits of the investors. As a result, this new domain of study makes an attempt to resolve the inefficiencies in the expected utility maximization of rational investors within efficient markets. Investors' irrational decisions can happen for two reasons. Firstly, sometimes they may process information that is wrong, and secondly when they analyse and interpret information with their inconsistent decisions. The behaviour of these investors is not always predictable, rational, and unbiased. Moreover, it does not always follow the conventional models of quantitative finance. As a result, the arrival of the subject has shown different ways and means by which financial decisions are made by investors and the factors influencing their investment psychology. Thus, behavioural finance challenges traditional finance by showing the inaccuracies of one's investment decision as it does not include psychological values into consideration (Statman, 1999).

The research paper has been structured as follows: The next section deals with the review of literature and research gap relevant to the present study. The subsequent section explains the research objectives and methodology used. The next section provides theoretical insights into the concept of behavioural finance. The following section gives a conceptual framework for the behavioural finance models used in the present study. The penultimate section provides the concluding observations and recommendations for the present study. The final section discusses on the limitations and future scope of behavioural finance. A list of research materials used has been provided at the end for future reference to academicians, researchers, and industry practitioners.

2. Literature Review and Research Gap

The theories of finance were built upon two core aspects and fundamental subdivisions,

one is known as Standard Finance which encompasses theories related to the rational behaviour of the investors and the other subdivision is known as behavioural finance which talks about the elements that drive the irrational behaviour of investors during a decision-making process. Standard finance further has two aspects: Traditional Finance which existed till 1950 and Modern Finance which came after traditional finance and remained till 1990 (Neumann and Morgenstern, 1944).

Traditional finance is based on the approaches of expected utility theory (Neumann and Morgenstern, 1944), the concept of economic man or *Homo Economicus,* Market Portfolio Theory (Markowitz, 1952), Capital Asset Pricing Model (CAPM) and Efficient Market Hypothesis (Fama, 1970). The rationality of investors supported by the Efficient Market Hypothesis (EMH), states that market prices fully reflect all the information available (Samuelson and Solow, 1960). It is believed that changes in the market prices rightfully reflect the information available for the short term and for the long term as it depends on the risk-taking ability of the market participants. All the models along with others like Capital Asset Pricing Model by Treynor, Sharpe and Lintner; Markowitz Portfolio Theory by Harry Markowitz (1952), Life Cycle Hypothesis by Modigliani and Brumberg (1954), do not take into consideration the human emotions and therefore fall under the category of conventional finance. The assumption of all these theories is that all investors make rational decisions, they are risk-averse, and their main objective is to maximize profit and well-being with the use of the utility curve. In the early 18th century, it was seen that the elements of emotions and communication like pride, insecurity, disgrace, and personal factors affected human behaviour towards their aim of profit maximization. But in the 19th century, development in economics took over neoclassical theories and the aspect of psychology as an element in economic development was not considered (Smith, 1998).

Behavioural finance started to emerge largely during the mid-1980s. Russell Sage Foundations came out to be a sponsor in this field of research which gave a head-start to the contributions in this field (Sent, 2004). Behavioural finance looks into the psychological aspects of the market participants, their behaviour and the final end results in the market. Its base was laid upon examining how individual investors react to information related to the market. This field of finance advocated the study of sociology, psychology, and behavioural sciences to understand the investor judgment process during finalizing an investment decision. The investors' decision-making process is not always rational and is embedded in cognitive biases and emotional characteristics. These biases deviate an investor from making rational decisions and from following the

conventional models of finance. De Bondt and Thaler, who belong to the group of researchers who are known as the founding fathers of behavioural finance, developed the Overreaction Hypothesis in the year 1985 which was a contravention to the Bayes' rule. This hypothesis states that news and information, that is unexpected, prompts an investor to react disproportionately.

At the beginning of the twentieth century, psychologists like Irving Fisher and John Mynard Keynes gave more importance to the psychological factors that drive the economic behaviour of investors (Loewenstein, 1992). Behavioural finance was also talked about as a theory that said people participating in the markets made decisions rationally but were subjected to a certain limit (Goldberg and Nitzch, 2001). Behavioural finance can be majorly divided into two categories, macro and micro-behavioural finance. Macro-behavioural finance deals with anomalies and micro deals with individual investors (Pompian, 2006). Shiller (2003) proposed the fact that various kinds of biases affect an individual investor. He referred to the feedback model and said that an investor is more likely to depend upon the actions and opinions of other investors rather than the new information that is present in the market. This kind of psychology shifts the decision-making process from the theory of the efficient market and brings disproportions into the process. Barberis and Thaler (2003) stated the concept of "limits to arbitrage" which says that the price of assets has different values other than their fundamental ones due to the decisions of irrational investors. The other concept discussed by them was "psychology", where the investors' choices tend to deviate from the rational systematic models when they make choices based on the choices of others. Different kinds of biases like overconfidence, conservatism, etc. affect and limit the beliefs of the investors. Behavioural finance when perceived in a simpler manner, adds psychological aspects of a human being into the standard theories of finance (Ritter, 1988).

The heuristics theory in the field of behavioural finance, postulated by Herbert A. Simon in the 1950s, suggested that humans use mental short-cuts to quickly form judgments, make decisions, and find solutions to complex problems thereby pointing out the limitations to rational decision-making. Further in the 1970s, psychologists Amos Tversky and Daniel Kahneman added to this field with the introduction of specific heuristic models on cognitive bias. Heuristics theory is defined as the rule of thumb, which individuals use in uncertain situations to make decisions simple and efficient (Tversky and Kahneman, 1974; Ritter, 1988). Kahneman and Tversky, (1979) observed that irrational people used heuristics in their decision-making because they fail to judge the perfect probability. Heuristics are useful if time is limited (Waweru *et al.*, 2008) and limited information (Tversky and Kahneman, 1974).

Therefore, irrational people do not collect all information, they just follow some mental shortcuts that make their decision-making process easier, simple and efficient (Abdin *et al.*, 2017).

The prospect theory in the field of behavioural finance, postulated by Daniel Kahneman and Amos Tversky in 1979, talks about investors' perceptions of profit or loss. They stated that investors do not weigh gains and losses similarly and an event of loss affects the investor more than an event of gain. Behavioural Asset Pricing Theory (BAPT) and Behavioural Portfolio Theory (BPT) were two major advancements in the field of behavioural finance. The BAPT theory's assumption is that stock return is a function of market return while BPT theory talks about how investors form different mental accounting layers derived from their experiences and ambitions which determine the objective of their investments (Statman, 1999). Statman also stated that in behavioural finance investors are not rational, and the market is not efficient. In this scenario, the traditional theories of finance do not showcase a plausible explanation for the volatility in returns of the stock market and that is why behavioural finance has successfully emerged as a strong ground in the field of finance.

Having reviewed the most relevant literature, the researchers have found little or no evidence of previous studies in India or abroad that provide insight into the theoretical and conceptual framework of the relevant behavioural finance models affecting an individual's decision-making process. In addition, none of the past studies reviewed the application of the heuristics theory and prospect theory on an investor's behaviour in making financial decisions. Hence, the present study intended to fill that research gap.

Hence, the present study has two-fold objectives which are listed as follows: (a). To provide an overview of the different dimensions and theoretical assumptions related to Behavioural Finance, and (b). To review the conceptual framework of the behavioural finance models, such as heuristics and prospect theories, on an investor's decision-making process.

3. Theoretical Foundations

The concept of behavioural finance has gone through various changes and developments from the time it was taken into consideration. Psychological Behaviourism, also called as Philosophical Behaviourism, was included in the study of psychology to understand the behaviour of individual organs which was considered to be a scientific study (Watson, 1913). Apart from studying behavioural traits in the human body, researchers also tried to interpret its impact on human financial decisions.

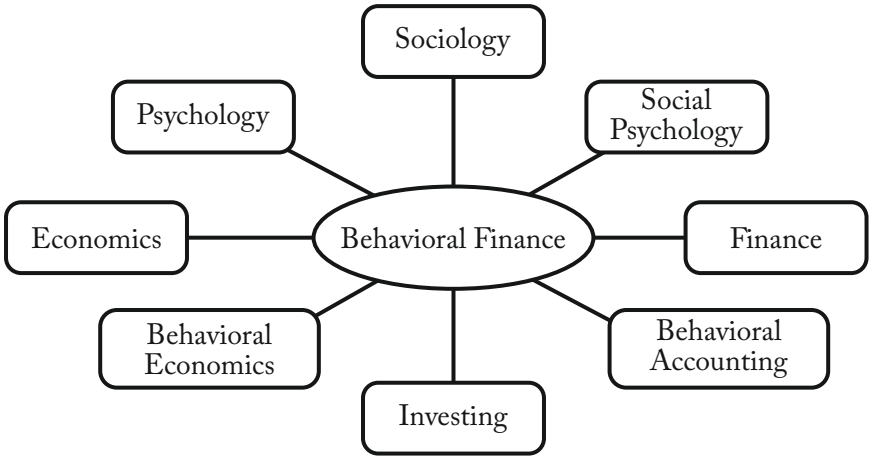
Behavioural finance is a study of how a human interprets and acts to make an informed financial decision while relying on the

information available to the person (Lintner, 1998). It is also said that behavioural finance seeks to understand and predict the financial market implications of the psychological decision process (Olsen, 1998). The domain of behavioural finance is growing very fast influencing the behaviour of the financial practitioner's psychology (Shefrin, 2000). Apart from the psychological viewpoint, behavioural finance also takes knowledge into consideration from financial theories as well (Fromlet and Huber, 2001). Behavioural finance has emerged as a blend of various branches of economics, psychology, social psychology, finance, behavioural accounting, investing and behavioural economics (Ricciardi, 2005), as shown in Figure 1.

The principal assumptions of behavioural finance can be noted as follows (Sulphey, 2014).

- Investors behave normally and they are not necessarily rational.
- Markets are not efficient, even if they are difficult to beat.
- Portfolios are designed following the rules of behavioural portfolio thinking and they are not based on the mean-variance portfolio theory.
- The returns are not just determined by risk.
- Investors generally look at past data which represents past returns and accordingly they make their investment decisions for future prospects of returns.

Figure 1: Dimensions of Behavioural Finance



Source: Ricciardi, 2005

3.1 Conceptual Framework

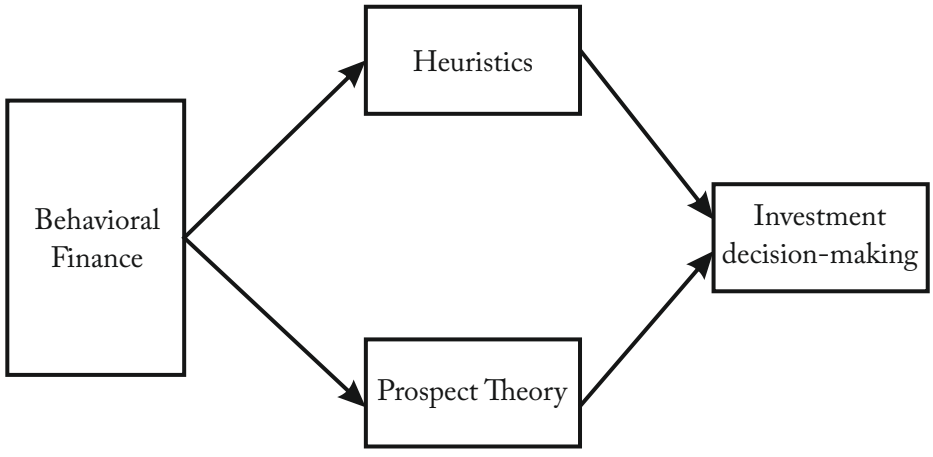
The human financial decision-making process goes through two main cognitive illusions, which are identified as the heuristics decision process and prospect theory which originates from behavioural finance (Virigineni and Rao, 2017), as represented below in the following Figure 2.

3.2 Heuristics Decision Theory

The Greek word heuristics means serving to discover. The process that includes heuristics is, individual investors seek to find out and establish further courses of action by themselves. It works through various methods of trial and error and guessing. The heuristics are efficient cognitive processes that ignore information available to the investors (Gigerenzer and Brighton, 2009). Here investors involve their mental and emotional factors while processing their decisions. Some of the heuristics have been discussed below, as shown in following Figure 3.

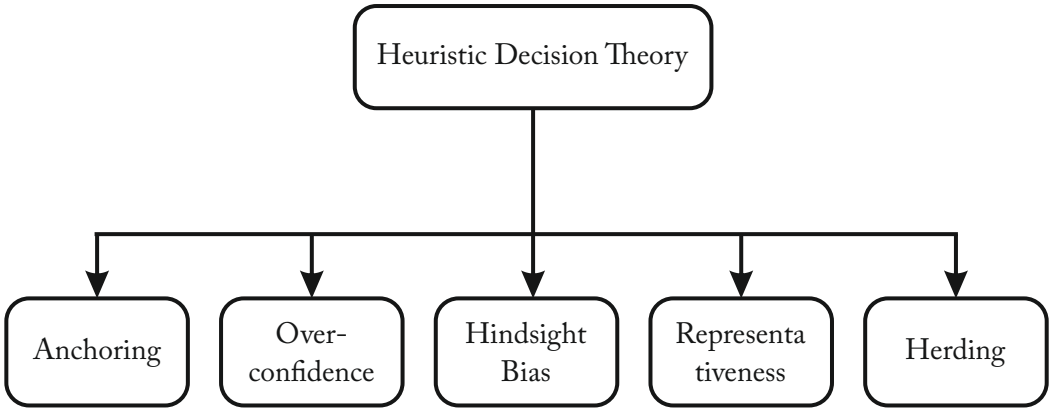
Anchoring characteristics in psychology come from proven evidence that human beings have a tendency to attach their thoughts to certain latest events as reference points. While doing so investors sometimes base their investment decisions on facts and figures which are completely irrelevant to them. Anchoring on the purchase price, historical price and historical perception are the most common reference points to investors (Chanda, 2008).

Figure 2: Conceptual Models on Behavioural Finance



Source: Virigineni and Rao, 2017

Figure 3: Behavioural Biases: Heuristics Decision Theory



Source: Virigineni and Rao, 2017

Overconfidence is the most powerful, consistent, and widespread psychological bias present in a human being. It is an error of human judgment that raises risk for him and for others as well. Overconfidence can also be defined as a self-deception form of human character. Baker and Nofsinger (2002) have proposed two factors as illusion of knowledge and illusion of control that contribute to human overconfidence.

Hindsight bias is a psychological tendency with which an individual believes that he could have accurately predicted a previous event, even when he couldn't do so in real time. The more familiar he is with the subject of the event, the smaller the effect of the hindsight bias will be (Christensen-Szalanski and Willham, 1991).

Representativeness bias tends to categorize events that represent a certain well-known class (Kahneman and Tversky, 1974). Based on stereotyping, the similarity heuristic leads investors to predict future outcomes while attaching to past records or the latest available resources to confirm their decision-making process. Representativeness can also come from the law of small numbers and create overreaction for the investors. When investors use small samples to predict the whole population they commit mistakes and errors in the process (De Bondt *et al.*, 1985).

Herding is the tendency of individuals to copy the actions of others. When the investor is unable to make his own choices, he follows what other investors are doing without thinking much about the consequences of the

decision for the later courses of action. Herding behaviour is quite opposite to the behaviour possessed during overconfidence. Investors choose to ignore their personal choices and decisions and blindly copy others' course of action, which leads to trading the financial markets in the same direction as a group (Nofsinger *et al.*, 1999; Bikhchandani and Sharma, 2001).

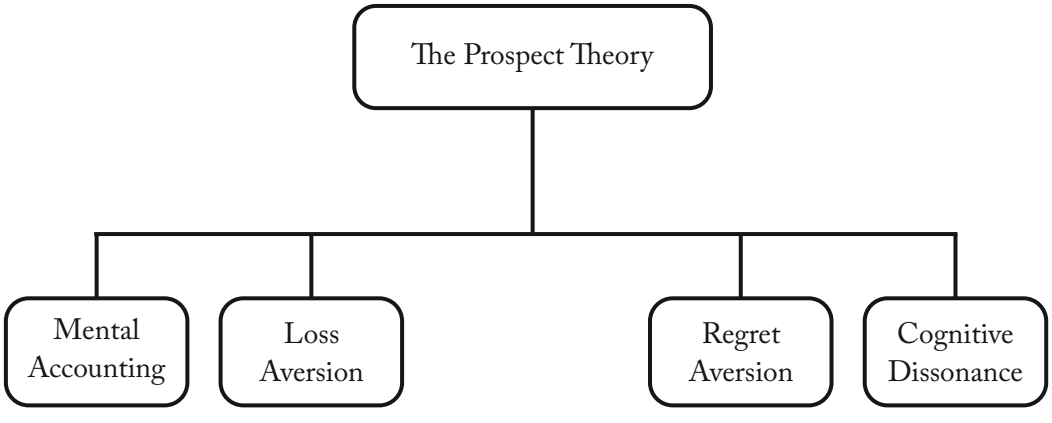
Abdin *et. al.* (2017) empirically examined the impact of heuristics on two stock market anomalies (fundamental and technical) that affect the investment performance of individuals. The study was the first of its kind to examine the four different components of heuristics independently such as overconfidence, representativeness, anchoring, and availability of stock market anomalies that impact individual investment performance. Based on a primary survey of 324 investors in the stock markets in Pakistan, the findings empirically showed that fundamental anomalies mediated the heuristics–investment performance link, while technical anomalies are not significant mediators of impact on the investment performance of individuals. Among the four heuristics components, availability and representativeness were the strongest predictors of investment performance, followed by fundamental anomalies. Overconfidence is also a positive predictor of investment performance of individuals followed by fundamental anomalies.

3.3 Prospect Theory

Kahneman and Tversky (1979) stated that a group of illusions may affect the decision-making process of any individual investor. Prospect theory explains how risk under uncertain conditions shapes human behaviour. The certainty effect in prospect theory suggests that individual investors place more value on certain outcomes of an event rather than probable outcomes of the same. Under the prospect theory, an individual's decision-making process is influenced by four different behaviour biases, as shown in the following Figure 4

Mental accounting is a process by which individual investors separate their assets into different groups based on distinctive functions or activities. The various subjective criteria for grouping can be a source of money, the purpose of accounts etc., (Thaler, 1985). This separation of assets and assigning various functions are sometimes irrational in nature and damaging to their decisions as well. Mental accounting has three components- firstly, the component that captures how the outcomes are perceived and experienced, and how the decisions are made and consequently evaluated. Secondly, a component is involved in the assignment activities, keeping track of the inflow and outflow of funds from each of the activities. Third, the component is concerned about the frequency of periodic evaluation of each account.

Figure 4: Behavioural Biases: The Prospect Theory



Source: Virigineni and Rao, 2017

Loss aversion is very much fundamental to individuals as they are often averse to losses psychologically. The psychological pain of losing is approximately double compared to the pleasure of winning. Human beings are not consistently risk-averse. According to the certainty effect, investors are risk-averse while realizing gains and become risk-takers while facing prospects of losses. Later on, the theory of loss aversion was extended to discuss myopic loss aversion, which explains long-term vision with reference to short-term gains and losses (Thaler, 1999).

Regret aversion is a general tendency of investors to avoid actions that create discomfort for their wrong investment decisions. They tend to hold stocks even if it is losing because of their nature of risk aversion. It means that they feel selling stocks could be a bad investment decision and when they stick to it and there is a further loss of their shares, they often come across mental stress and pain. Often it is said that this regret aversion is a tax-inefficient strategy and by incurring losses investors can reduce their taxable income, and as a result, they lose out on their capital realizable value. Regret aversion theory has further been studied by Bell (1982), Ferris *et al.* (1988), Pompian (2006) and Coffie (2013).

Cognitive dissonance is a form of mental conflict that investors experience when they come across conflictive evidence that is against their long beliefs or assumptions and they tend to adjust such beliefs to justify occurrences in the past. Individual investors feel distressed by various conflicting cognitive elements such as empirical proof and their past courses of decisions (Festinger, 1957).

Sometimes they also tend to discard new data that negates their beliefs and choices.

The applications of prospect theory in the field of finance help in understanding the portfolio choices and trading behaviour of both individual investors and money managers in the financial market, such as why many investors tend to hold on to their losses and why they hold very undiversified portfolios. Prospect theory has also been applied to explain almost all well-known asset pricing "anomalies" including the equity premium puzzle, the profitability of value and momentum strategy, excess volatility, initial public offering (IPO) under-pricing and long-term performance of IPOs (Han and Hsu, 2004).

Barberis (2013) stated that the application of prospect theory was most actively felt in the field of finance and insurance where investors' attitude towards risk plays a central role. He has discussed the application of prospect theory in finance in three main contexts, such as (a) in the cross-section of average returns, where the goal is to understand why some financial assets have higher average returns than others; (b) in the aggregate stock market; and (c) in the trading of financial assets over time. On the insurance front, prospect theory had its applications mostly in evaluating investment decisions in consumer insurance markets in the areas of property and casualty insurance, mortality insurance (the main products here are life insurance and annuities), and health insurance. He has further pointed out that public finance, health economics and macroeconomics remain the areas where prospect theory has not been applied extensively though it has the potential to offer useful insights.

4. Summary and Conclusion

Behavioural finance has yet to enter into various domains of finance. Behavioural finance can be used to judge the decision-making process of individuals not only who are participating in the markets but also of top executives running huge businesses. Their cognitive biases and heuristics can be understood to explain the reasons behind a specific decision related to the company. Behavioural finance has incorporated many other factors related to emotions, motivation, attitudes, religions and ideologies that affect one's behaviour while making a financial decision. In order to gain more strength in this field, new advancements in technology like artificial intelligence, machine learning, and quantum computing can contribute largely. Every individual goes through different sets of experiences in life and has different ideologies inherent in persons. These factors collaboratively drive the financial decisions of an investor or of a top manager in a company. From the data of a huge mass of people, if a pattern of behavioural and emotional biases can be obtained then the number of mistakes performed can be reduced. These latest technologies would play a huge role in

analysing large sets of data of investors and people involved in financial decision-making. A smaller number of mistakes will help the market to develop and thereby the economy will grow faster. When such patterns could be achieved, behavioural finance would gain a stronger footing in terms of its theoretical models that aptly comprehend the volatility in the markets due to specific information.

The factor of a large dataset might bring out a pattern in the biases and cognitive errors but still, the accuracy of the patterns may not be fully acceptable. Each and every individual has different attitudes and emotions, therefore a generalized pattern might be able to solve a part of the existing problems in the process of financial decision-making but may not be entirely successful in coming out with a solution for each and every mistake. The mistakes would definitely be lesser in number but would never fully end. In this way, volatility in a market shall also be reduced to a certain level although the reverse might happen in terms of a single individual. Advanced technologies would be able to analyse the biases somewhat perfectly in an individual and lessen the mistakes to a high degree. Behavioural finance when properly developed has the ability to take over the traditional finance theories and form a strong anchorage in the domain of finance and financial decision making.

5. Limitations and Future Scope

Behavioural finance equips individual investors, and financial professionals with a new set of observations that helps them analyse, interpret, and avoid many psychological traps that involve emotions and human cognitions. Due to heuristics and biases, psychological traps are prevalent across all areas of the financial decision-making process. Applications of behavioural finance are applicable to investors, corporations, financial markets, and education.

Behavioural finance can be applied to an investor's advantage, but too often investors themselves fall into the trap of behavioural finance which ultimately manipulates them. The first step for investors to learn is to identify all the potential biases (Jordan *et al.*, 2015). They need to identify major biases such as heuristics, prospect theory, overconfidence, and herding etc. Learning from past mistakes by falling prey to these biases, investors need to protect themselves from making the same mistakes again. At the same time, they need to be aware of their emotional roller-coaster while making individual investment decisions.

The financial decision-making process is considered to be a complex process that is done through careful consideration of multiple possible factors. The most crucial factors arise from the investors' age, gender, race, education, demographic profile and socio-economic conditions. Behavioural finance is a part and parcel of the decision-making process because of its active influence

on the performance of investments in the stock market and mutual funds which are directly linked to an individual's risk-taking abilities. Market participants are always prone to making irrational behaviour. Hence, behavioural finance can be greatly helpful to understand emotional constraints and psychological biases, while making investment decisions and minimize or eliminate them as far as possible. Lastly, it seeks to find answers to questions such as what, why and how much of financial investment from an irrational and natural human perspective.

The information related to the present study has been derived from secondary sources, with no emphasis on primary research. Moreover, the study is descriptive in nature with no emphasis on empirical findings. In spite of these limitations, the present study provides a direction for academicians and researchers to empirically explore the dimensions of behavioural finance as probable areas of future research.

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Machine Learning-based Identification of Livelihood Lifeline Regions in Chikamagaluru District, Central Western Ghats

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Abstract

Livelihood lifeline regions are ecologically fragile regions that sustain natural resources but are vulnerable even to minor disturbances and hence require prudent management to maintain the region's integrity. Identification of ecologically fragile regions is possible considering landscape dynamics with bio-geo-hydro-climatic-social variables. Objectives of the current study are to (i) evaluate landscape dynamics through assessment of Land Use Land Cover (LULC) and (ii) identify and prioritize Livelihood Lifeline Regions (LLR) or Environmental Fragile Regions (EFRs) through integrated approaches considering ecological, biological, geo-climatic, and social variables. The current research focuses on the use of an Artificial Intelligence (AI) based Random Forest algorithm, a supervised Machine Learning (ML) classifier using temporal remote sensing data (1973 to 2021) of Chikamagaluru district, Karnataka state, India. Land use classification showed a decrease in forest cover (48.91 per cent) with an increase in agriculture (6.13 per cent), horticulture (43.14 per cent), and built-up cover (2.10 per cent). Livelihood lifeline regions (EFR1 to EFR 3) are to be protected to sustain the livelihood of local people with the sustenance of natural resources, and EFR4 denotes the least environmental fragility. The outcome of the current research would aid in policy-making toward optimizing local livelihood and economy through the prudent management of natural resources.

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Keywords: Land Use Land Cover (LULC), Artificial Intelligence (AI), Machine Learning (ML), Random Forest (RF), Ecologically Fragile Regions (EFR), Livelihood Lifeline Regions (LLR).

1. Introduction

The sustenance of natural resources depends on a region's ecological fragility, which indicates the degree of vulnerability that alters species abundance and composition. The extent of vulnerability is assessed by considering agents and impacts on the ecosystem. Ecological fragility assessment helps to identify the quantitative and qualitative vulnerable status of the region (França *et al.*, 2022), helps to visualize and plan for regulating disastrous anthropogenic activities through prudent ecosystem management with the active participation of all stakeholders to sustain livelihood lifeline systems (Ramachandra *et al.*, 2022a). Conservation of ecosystems requires insights of ecological, biological, and cultural dimensions. The ecological dimension refers to the natural environment, such as ecosystems and ecological processes, while the cultural dimension refers to the political, social, technological, and economic aspects (Ramachandra *et al.*, 2018). Delineation of Environmental Fragile Regions (EFRs)/Livelihood Lifeline Regions (LLR) considering bio-geo-hydro-climatic variables with environmental and social aspects is essential to evolve strategies for enduring ecosystem processes to sustain biodiversity. Multiple levels of EFR or LLR (with grids prioritized based on the cumulative eco-sensitive metrics score) help the decision-makers opt for eco-friendly development measures and aid in effective regional planning.

Landscape comprises heterogeneous elements with diverse ecological, biological, geological, hydrological, social, economic, and environmental characteristics. The ecological processes in a region depend on the landscape structure or characteristics. The mosaic of interacting landscape elements is vital for sustaining ecosystem processes or activities, which are termed Environmental Fragile Regions (EFRs) or Livelihood Lifeline Regions (Ramachandra *et al.*, 2022b). The ecological processes deteriorate due to the sustained anthropogenic interferences with unplanned developmental activities (Hu *et al.*, 2021).

Alterations in the structure of a landscape due to natural or anthropogenic activities are accounted for through temporal land cover (LC) and land uses (LU). A quantitative analysis of LU and LC determines the extent and condition of ecosystems (Ramachandra and Bharath, 2012), indicating the level of human interactions and associated changes. The availability of spatial data at regular intervals through space-borne sensors and advancements in geoinformatics with machine learning algorithms have been aiding in the provision of information required for assessing landscape dynamics.

Unplanned developmental activities have altered the structure of the landscape, inducing fragmentation of contiguous forests, which are detrimental to the sustenance of biodiversity, carbon sequestration potential, and other ecological services at local and global scales (Liu *et al.*, 2019). Fragmentation of forests creates disturbances in ecological and socio-economic processes with habitat loss, distribution of habitats into patches, a decrease in habit patch size, loss of species diversity, etc., leading to disruptions in wildlife habitats and aggravating human-wildlife conflicts (Ritters *et al.*, 2000). Hence, information on landscape dynamics focusing on the extent and condition aids in prioritizing the area for planning, managing, and conserving biodiversity to sustain livelihood support socio-economic activities (Chughtai *et al.*, 2021; Ramachandra and Kumar, 2011). The structure and composition of the landscape are ascertained through spatial matrices.

Recurring mudslides and landslides in recent years have necessitated identifying and prioritizing Livelihood Lifeline Regions (LLR) and Environmental Fragile Regions (EFR) in Chikamagaluru district of Karnataka. There have been significant efforts to understand the landscape dynamics, including ecosystem conditions, through fragmentation assessment (Chughtai *et al.*, 2021; Ramachandra and Kumar, 2011; Hu *et al.*, 2021; Liu *et al.*, 2019; Khalidkar, 2019; Ramachandra *et al.*, 2019), but mapping environmentally fragile regions at disaggregated levels considering ecological, biological, geo-climatic, and social variables would facilitate in the sustainable management. The novelty of the research is assessing and geo-visualizing LLR and EFR in a heterogeneous landscape, by taking advantage of recent advances in geoinformatics through spatial big data and machine learning algorithms.

The availability of long-term, multi-resolution remote sensing data (spatial big data) helps to identify and quantify land use dynamics and understand the impacts of unplanned anthropogenic interventions. Integrating land use information with collateral data through a Geographic Information System (GIS) aids in comprehending land use information with agents of change, including policy interventions (Vivekananda, 2021). Recent advancements in the classification of big data (spatial) through artificial intelligence (Khalidkar, 2019) based on machine learning aid in making an informed optimal decision due to the availability of accurate land use information in less time. Random Forest classifier (RFC) based on ensemble methods like bagging and boosting is the most widely used ML algorithm (Breiman, 1996). RFC provides accurate LU classification for heterogeneous landscapes through a set of decision trees from a randomly selected subset of the training set and aggregates decisions for deciding the final class. RFC randomly selects

variables from training samples at each node to determine the best split to construct a tree based on the Gini index measure that gives a measure of impurity within a node. The accuracy of the classifier is assessed through samples (not used for training), which provide unbiased error estimates. The performance of three supervised learning non-parametric techniques (Random Forest classifier (RFC), Support Vector Machine (SVM)), and parametric technique (Maximum Likelihood classifier (MLC)) were assessed, and results reveal that non-parametric based RFC performed better with an overall accuracy and kappa value (Ramachandra *et al.*, 2023). Integrated landscape assessments considering bio-geo-climatic, with ecological, environmental, and social characteristics, are required to delineate Environmental Fragile Regions (EFRs). Prioritization of EFRs at disaggregated levels is essential for planning interventions to ensure sustainable development and maintain the ecological balance in the environment.

1.1 Objectives

Objectives of the current study include: (i) assessing landscape dynamics through LULC in Chikamagaluru district, Karnataka State, India using temporal remote sensing data and (ii) identification and prioritization of Livelihood Lifeline Regions (LLR) or Environmental Fragile Regions (EFRs) considering ecological, biological, geo-climatic and social variables.

2. Materials and Method

2.1. Study Area

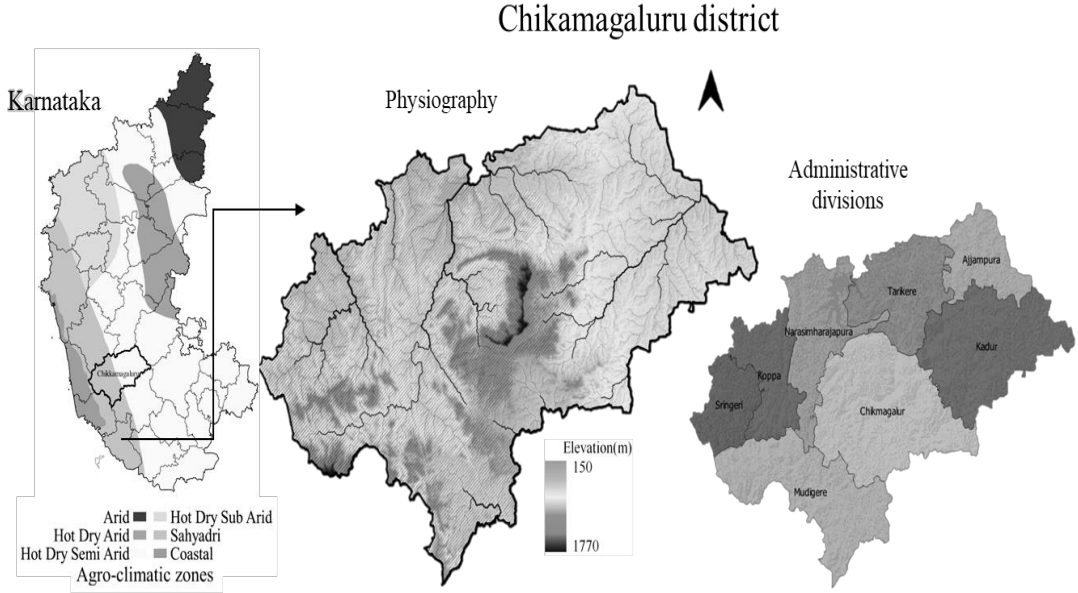
Chikamagaluru district, with a spatial extent of 7101 sq. km (3.8% of Karnataka), lies in the south-western part of Karnataka between 12° 54'42" and 13° 532 53" N and 75° 04'46" and 76° 212 50" E (Fig 1). The district landscape spans three agro-climatic zones the hilly zone (Chikamagaluru, Koppa, Mudigere, Narashimharajpura, and Sringeri), the central dry zone (Kadur), and southern transition zone (Tarikere). The district of Chikamagaluru is divided into two distinct regions, the western part being a forested hilly area known as the 'Malnad' area. In contrast, the eastern part is dominated by a plain region or 'Maidan' area. The forest cover in the district is managed by five administrative forest divisions, including Chikamagaluru, Koppa, Bhadravathi, Kudremukh National Park, and Bhadra Wildlife Sanctuary. The vegetation in the district can be broadly categorized into four types: dry deciduous hill type, moist deciduous type, evergreen type, and Sholas and Grassland type. Mullayanagiri, the highest peak in the district, rises 1926 meters above MSL. The major rivers in the district are Tunga and Bhadra, while other perennial rivers include Hemavati, Netravati, and Vedavathi.

The major horticulture crops grown in the district are areca nut, coconut, black pepper, banana, mango, cardamom, ginger, and vegetables. Due to the presence of extensive

hilly areas, the climate in the district is pleasant, with April being the hottest month, with a mean daily maximum temperature of 36°C and a mean daily minimum temperature of 19°C. The average annual rainfall in the Chikamagaluru district is 1925 mm, ranging from 595 mm to 2379 mm.

Chikmagaluru district consists of seven administrative taluks - Chikamagaluru, Kadur, Koppa, Mudigere, Narashimharajapura, Sringeri, and Tarikere (Ajjampura and Tarikere taluks as per the 2021 statistical report). According to the 2011 Census, the district has a total population of 1137961, accounting for 1.9 per cent of the state's population, and ranks 25th in Karnataka. About 81 per cent of the population lives in rural areas, while the remaining 19 per cent live in urban areas. The district is well-connected by road to Hassan, Mysore, Bangalore, Shivamogga, Udupi, and Mangaluru, and the nearest airports are Mysore and Mangalore. There are two railway junctions at Kadur and Birur. The economy of the district is primarily based on rural agriculture and supplemented by tourism income.

Figure 1: Location of Study Area – Chikamagaluru District, Karnataka, India



Source: Authors' Compilation

2.2 Method

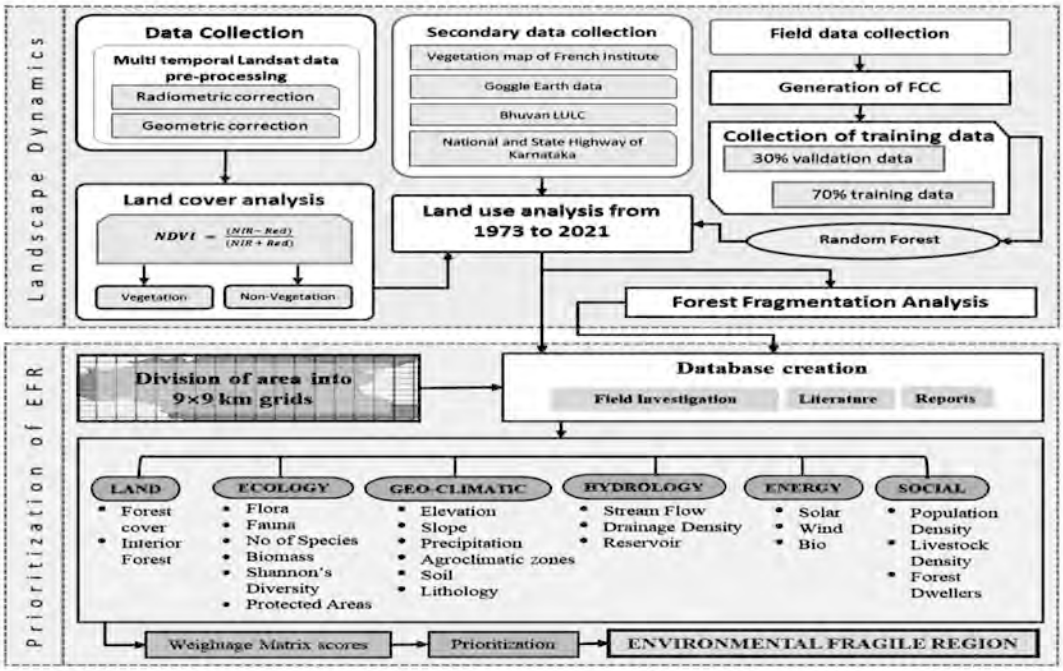
The method adopted for assessing LULC changes and prioritising livelihood lifeline regions (LLR) or ecological fragile regions (EFR)in Chikamagaluru district, Karnataka State, India, at disaggregated levels, is outlined in Figure 2.

2.1.1. Land use Land cover (LULC) dynamic

Land cover analyses involving delineation of the district into vegetation and non-vegetation, through computation of the Normalized Difference Vegetation Index (NDVI).

Land use dynamics were computed using temporal remote sensing data (1973 to 2021) through RFC, a supervised machine learning algorithm in the Google Earth Engine platform[5]. Remote sensing data was analyzed by (i) pre-processing of RS data to maintain geometrical and radiometric consistency, (ii) generation of false color composite (FCC) using NIR, Red, and Green spectral bands of Landsat data, which helps in identifying

Figure 2: Protocol for Analyses of Landscape Dynamics and Prioritization of LLR/EFR at Disaggregated Levels



Source: Authors' Compilation

[5]Retrived from : https://earth.google.com

heterogeneous patches in the landscape, (iii) digitizing training polygons in FCC (corresponding to heterogeneous patches spread across and covering at least 15 per cent of the district and supplemented with digitation from the Google Earth image. 70 per cent of the training polygons were used in the supervised classifier RFC), and (iv) validation of classification considering 30 per cent of training polygons

Random Forest Classifier (RFC) is a supervised machine learning algorithm that classifies data into various LU considering several decision trees on various subsets of the given dataset and takes the average value to improve the predictive accuracy of that dataset (Breiman 1996, Breiman, 2001). RFC is designed to handle the prediction from each tree, and predict the final output based on the majority votes of predictions. The land use information is cross-verified with the collateral data such as (i) the vegetation map of South India of the French Institute[6], (ii) vegetation maps from Karnataka Forest Department[7], and (iii) the Survey of India (SoI) topographic maps[8].

LU change (per cent) for each category was calculated considering base year (1973) and current year (2021) data as per equation 1.

2.1.1. Prioritization of LLR/EFRs

EFR or LLR refers to vulnerable areas with high sensitivity and fragility based on the environmental aspect, where anthropogenic activities can cause large-scale disturbances in the natural habitats, affecting the ecosystem processes. The district was divided into 5'X5' grids (9 km X 9 km) equivalent to a grid in the Survey of India topographic map of 1: 50000 scale to calculate the Environmental Fragile Regions (EFRs) at disaggregated levels. Grid-based (disaggregated level) mapping is a standardized approach to collecting spatial data that efficiently compiles large datasets where the output can be consistent and comprehensible. Each grid was assigned values according to its landscape dynamics, ecological, bio-geo-climatic, hydrological, locally available energy resources (renewable), and social characteristics data, which were compiled from field surveys and supplemented with the information from published scientific literature, published

Equation 1

$$Change\ Rate = \left(\frac{Land\ use\ area\ of\ current\ year - Land\ use\ area\ of\ base\ year}{Current\ year - base\ year} \right) * 100 \ldots\ldots (1)$$

[6]Retrived from : https://www.ifpindia.org/bookstore/fmsi-mp6/

[7]Retrieved from : https://aranya.gov.in/aranyacms/images/Maps/Mosaic/Forest%20Type.pdf

[8]Retrieved from : https://www.surveyofindia.gov.in/

datasets (Karnataka Forest Department), forest administrative reports, district statistics (district at a glance), etc. The study region is delineated based on a cumulative weightage metric score at disaggregated levels based on multi-disciplines knowledge (Termorshuizen and Opdam, 2009).

Landscape dynamics essentially provide the extent of temporal land uses and condition of the forest (contiguity of forests - interior forests, etc.). Ecology consists of flora and fauna, biomass, carbon sequestration, no of species, Shannon's diversity, and protected areas under reserve forests, conservation areas, sacred groves, etc. Geo-climatic parameters refer to the various geological and climatic parameters such as rainfall, elevation, slope, soil, agro climatic zones, and lithology. Hydrological parameters include drainage density, stream flow, and reservoir presence. The prospect of renewable energy like solar, wind, and bioenergy has also been considered. The social aspects included population density, the presence of forest dwellers, and livestock density. Finally, a weightage matrix was used to generate weights for each variable of various themes, considering the relative significance of themes (equation 2).

An indicator defines each criterion mapped to a value normalized from 10 to 1. The value 10 corresponds to a significantly higher priority for conservation. The value 7, 5, and 3 corresponds to high, moderate, and low levels of conservation. The approach is based on the standard protocol or framework (Beinat, 1997) for weighing ecologically fragile regions, as it provides an objective and transparent system for combining multiple data sets together. The weightages, based on an individual representation and illustrated extensively on GIS techniques, stand out as the most effective method. For this study, the weights are assigned as per earlier research (Table 1, Ramachandra *et al.*, 2018).

Equation 2

$$Weightage = \sum_{i=1}^{n} W_i V_i \quad \ldots\ldots 2$$

where,
n is the number of variables,
W_i is the weight associated with criterion I, and
V_i is the associated variable value.

The aggregated weightage for each grid is generated and grouped based on mean and standard deviation to determine the various levels of fragility. EFR 1 (or LLR 1) represents ecologically highly fragile, requiring strict conservation measures, EFR 2 (LLR 2) is less fragile than EFR 1, except degradation of some forest patches. EFR 3 (LLR 3) represents a moderate conservation region, and EFR 4 (LLR 4) represents less fragility. Identifying EFR/LLR at disaggregated levels would help conserve ecologically fragile regions and implement location-specific developmental activities required for the welfare of local residents.

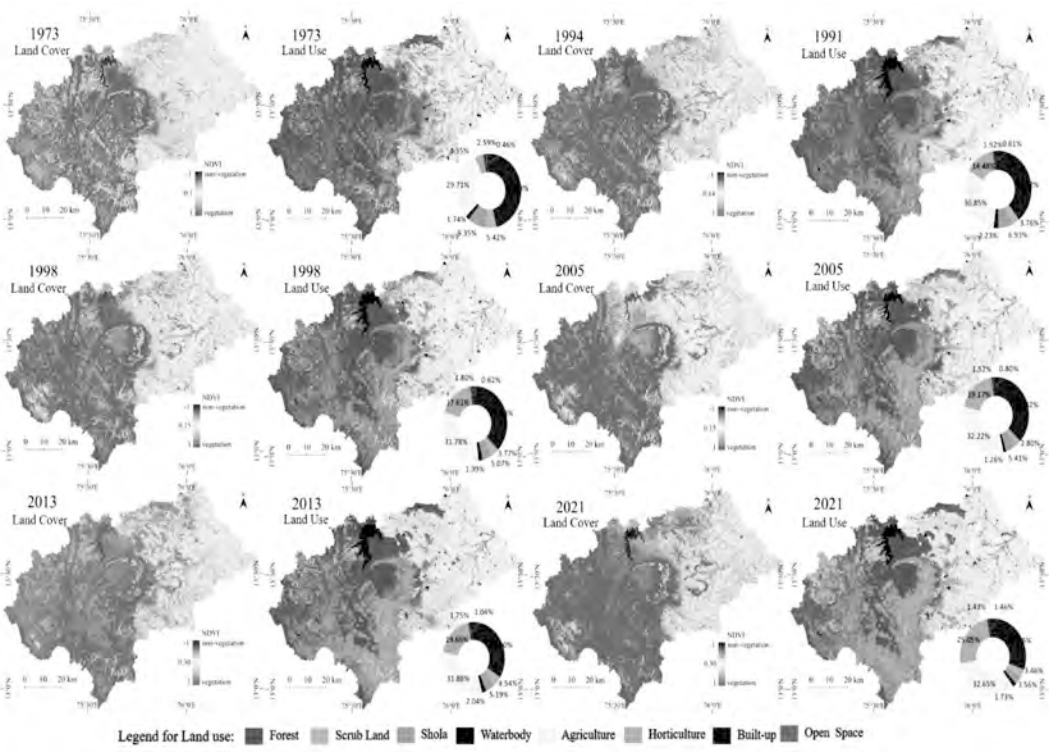
3. Results

3.1. Land Use Land Cover Analysis

Temporal LULC analyses were carried out using remote sensing (Landsat series) data from 1973 to 2021 through RFC. Figure 3 depicts land cover and land use in Chikamagaluru, with the Western Ghats region having higher forest cover. The district has witnessed large-scale LU transitions, evident with the decline of forests from 46.38% (1973) to 30.65% (2021), or from LC showing a decline in vegetation cover from 65.5% (1973) to 62.73% (2021). Large tracts of forests were lost due to developmental activities such as constructing dams and reservoirs, land conversion for built-up areas, agriculture (croplands and horticulture), etc.

Table 1 lists category-wise LU dynamics, which highlights an increase in the built-up cover from 0.46% (1973) to 1.46% (2021),

Figure 3: LULC of Chikamagaluru from 1973 to 2021



Source: Authors' Compilation

Table 1: Land uses of Chikamagaluru from 1973 to 2021

		1973	1991	1998	2005	2013	2021	Change
Forest	sq. km	3345.44	2828.66	2695.07	2656.15	2445.31	2210.96	-2363.5
	%	46.38	39.22	37.36	36.82	33.90	30.65	-32.77
Shola forest	sq. km	390.77	271.17	272.04	201.81	327.32	249.61	-294.09
	%	5.42	3.76	3.77	2.80	4.54	3.46	-4.08
Scrub land	sq. km	674.65	499.93	365.35	390.32	374.29	256.98	-870.14
	%	9.35	6.93	5.07	5.41	5.19	3.56	-12.06
Waterbody	sq. km	125.84	160.93	143.28	90.67	146.94	124.48	-2.83
	%	1.74	2.23	1.99	1.26	2.04	1.73	-0.04
Agriculture	sq. km	2143.02	2225.07	2292.52	2324.31	2299.71	2355.09	441.81
	%	29.71	30.85	31.78	32.22	31.88	32.65	6.13
Horticulture	sq. km	313.43	1044.68	1270.18	1382.50	1418.43	1807.16	3111.93
	%	4.35	14.48	17.61	19.17	19.66	25.05	43.14
Open space	sq. km	187.04	138.61	130.09	109.65	125.91	103.27	-174.52
	%	2.59	1.92	1.80	1.52	1.75	1.43	-2.42
Built-up	sq. km	32.83	43.95	44.49	57.61	75.09	105.47	151.33
	%	0.46	0.61	0.62	0.80	1.04	1.46	2.10

agriculture from 29.71% (1973) to 32.65% (2021), and horticulture from 4.35% (1973) to 25.05% (2021). The decline in the spatial extent of forests, and scrub lands highlights the need for sustainable LU policies to arrest land degradation and deforestation. The natural forests show a decline, evident from the decrease in evergreen forests from 800.14 sq. km (1973) to 706.38 sq. km (2021), shola forest 390.77 sq. km (1973) to 249.61 sq. km (2021), moist deciduous forests from 1960.01 sq. km (1973) to 1139.64 sq. km (2021), dry deciduous forests from 457.41 sq. km (1973) to 368.03 sq. km (2021) and scrub forest from 674.65 sq. km (1973) to 56.98 sq. km (2021). The Bhadra wildlife sanctuary and Kudremukh National Park have the densest forests in the district. Large-scale monoculture plantations of eucalyptus, rubber, acacia, teak, and areca nuts have increased by replacing the forest areas. These abrupt changes have resulted in the imbalance of ecosystems, affecting the hydrologic regime and availability of natural resources.

Table 2: Accuracy of LU classification

Accuracy Assessment	evergreen	moist deciduous	dry deciduous	scrub	shola forest	waterbody	open space	cropland	fallow land	horticulture	built-up	rocky surface	Kappa statistics	Overall Accuracy
Commission	24.4	16.6	14	32	44	0	26	22	16	22	33	43	0.857	90.212
Omission	29.4	22.5	23	32	52	9	25	26	13	13	66	22		

An accuracy assessment of LU classification was done through the computation of category-wise accuracies and Kappa statistics. Table 2 lists the category-wise accuracies, which indicate that the overall accuracy and kappa statistics show 90.21% and 0.85, respectively.

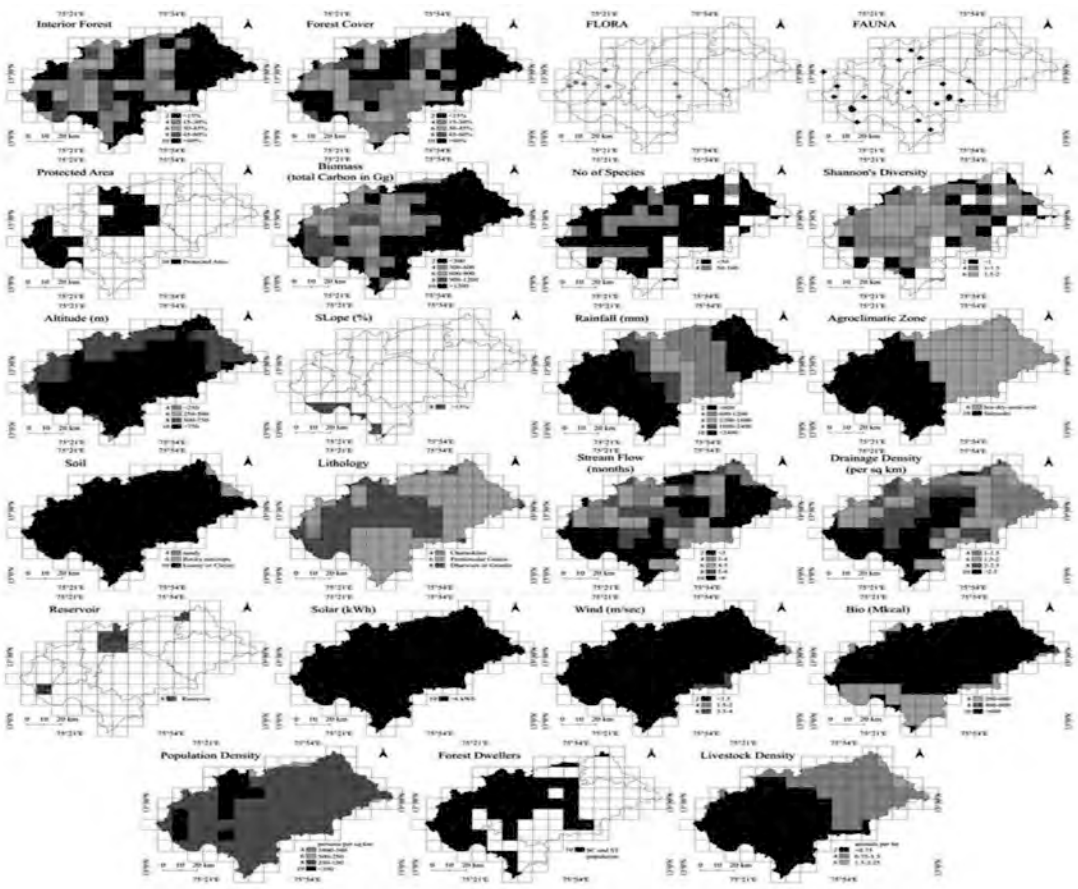
3.2. Ecological Fragile Regions (EFR)

Attribute data of ecology, geo-climate, land, energy potential, hydrology and social aspects were compiled (Figure 4), and weights were assigned and aggregated grid-wise to delineate the EFR/LLR at disaggregated levels.

Chikamagaluru district has a dense evergreen forest at the Kudremukh forest range in the western part and a deciduous forest in the middle section, including Churchegudda Reserve Forest, and Kalesapura Reserve Forests. The maidan region in the eastern part of the district has a forest cover of <30 %. Intact contiguous (interior forests) forests are in Narasimharajapura and Sringeri taluk.

The ecology of Chikamagaluru district was assessed from the data of flora, fauna, biomass and carbon, abundance of species, Shannon's diversity, the status of conservation reserves, etc. The spatial distribution of endemic flora and fauna compiled from the field through transect - quadrats-based vegetation and fauna sampling. The presence of numerous endemic species of flora and fauna highlights of the ecological significance of the district. The density of species and Shannon's diversity are higher in the forest areas of the district. The biomass concentration is higher in the evergreen forests and has >1200 Gg total carbon, while deciduous forests have 300-900 Gg total carbon. Bhadra tiger reserve and Kudremukh forest range are the protected areas in the district.

Figure 4: Weights of Bio-Geo-Climate-Social Variables, Assigned Grid-Wise, Chikamagaluru District



Source: Authors' Compilation

The district has an average elevation of >750 m, and some parts in the east and north have 250-500m elevation. The slope is less than 15% in the whole district except in the Kudremukh Range in Mudigere taluk. The district has a decreasing rainfall pattern from west to east. The Western Ghat section receives an annual rainfall of >2400 mm, the middle part of the district with forest cover receives 1200-2400 mm, the middle part without forest cover receives 600-1200 mm, and the eastern part receives <600 mm of rain. The district has two agroclimatic zones - the Western Ghats or Sahyadri in the west and

hot-dry-semi-arid in the east. The eastern and southwestern part of the district comprises Peninsular Gneiss, and the higher elevated regions are composed of Dharwars or Granite area. Loamy or clayey soil is found in the whole district.

Chikamagaluru district has Tunga, and Bhadra rivers in the western hills and Vedavathi River in the east. The streams in the forest region have >6 months of water availability, and rivers in the plain region have <3 months of water. Similarly, forested hilly areas have >2.5 per sq. km drainage density, and the plain area has 0.5-1 per sq. km drainage density. The Bhadra reservoir in this district is one of the biggest reservoirs in Karnataka.

The whole district has more than 6 kWh of solar energy potential. Also, the entire district has less than 1.5 m/sec wind speed throughout the year. Bioenergy potential (Ramachandra and Gunasekaran, 2019) is >600 MKcal in the district except in the Western Ghats region.

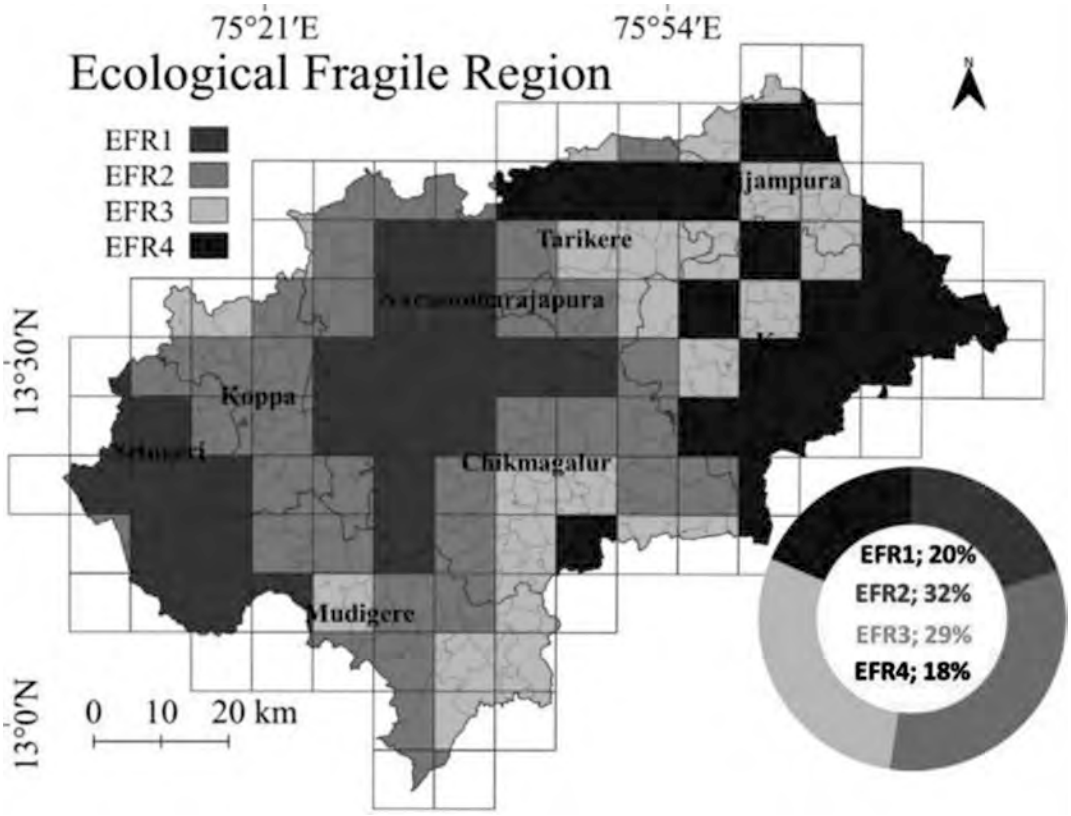
The population density is 250-100 persons per sq. km in the whole district except Narasimharajapura and Sringeri taluk, where the population density is <100 persons per sq. km. Livestock density is 2.25-3 animals per ha in the eastern part and 1.5-2.25 animals per ha in the western part. The presence of forest dwellers is identified at Narasimharajapura, Koppa, and Sringeri taluk.

The aggregated weights (Figure 4) were analysed (frequency distribution), and grids were prioritized based on the relative score to delineate Ecological Fragile Regions (EFRs) or Livelihood Lifeline Regions (LLR).

Chikamagaluru district has been classified into four level of ecological fragility where each level is interconnected with other. Results reveal that 25 grids are EFR1, 38 are EFR2, 30 are EFR3, and 28 are EFR4 (Figure5).

EFR1 represents a zone of highest conservation and requires stringent conservation norms without further degradation. The protected areas and evergreen forests are under EFR1 zone. EFR2 has the potential to become EFR1 provided with strict regulations and improvement of forests. A small change in EFR2 can have more adverse effects on EFR1, so it is recommended to impose a complete ban on the over-exploitation of forest resources. The study highlights the critical role of active stakeholder participation, particularly involving local communities, in the conservation of forests. The delineation of Environmental Fragile Regions (EFRs) at a granular level has been identified as a valuable tool for policy formulation for effectively managing land resources in the Chikamagaluru region. The study stresses the importance of protecting Livelihood Lifeline Regions, spanning from EFR1 to EFR3 to sustain the livelihoods of local people while ensuring the preservation of natural resources. The research findings are expected to contribute to policy development for

Figure 5: Grid-Based and Gram Panchayet Based Ecological Fragile Regions of Chikamagaluru



Source: Authors' Compilation

implementing sustainable development practices. The goal is to enhance livelihood options for local communities while minimizing further degradation of ecosystems in the region. Planting native endemic species would maintain the balance and ensure the sustenance of water (throughout a year), while improving biodiversity and pollination services (higher yield) to sustain the livelihood of local people.

4. Conclusion

Ecological Fragile Regions (EFRs) Livelihood lifeline regions (LLR) are delineated at disaggregated levels in the Chikamagaluru district of Central Western

Ghats using temporal LU information based on machine learning algorithm with bio-geo-climatic, hydrologic, ecological and social variables.

LULC analysis showed a continued decline of 2363.5 sq. km of forest cover from 1973 to 2021, with increased agricultural and horticultural lands. Built-up areas have also increased by 151.33 sq. km with increased industrial and infrastructure development.

The prioritization of Ecological Fragile Regions at disaggregated levels revealed that highly sensitive EFR1, covers 20% of the district. The delineation of EFRs at disaggregated levels helps in policy formulation to manage land resources and suggesting landslides mitigated measures for in Chikamagaluru (Ramachandra et al., 2020). Livelihood lifeline regions (EFR1 to EFR 3) are to be protected to sustain livelihood of local people with the sustenance of natural resources. The outcome of the research would aid in policy formulations toward implementing sustainable development practices to enhance livelihood options with the minimisation of further degradation of ecosystems.

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Bibliometric Analysis on Research in Meditation and Future Trends through R Software

Shibaprasad Parhi[1]

Abstract

A conceptual study was carried out in the field of meditation with the application of advanced text-mining tools of R software. The R software with the Bibliometrix package along with the graphical interface Biblioshiny is presented. The research was carried out to understand the various aspects. The publications under the search words were collected from the years 1980 to 2020. Major contributing sources are highlighted and it is observed hardly 2 bibliometric analyses were carried out in this field in the past. So an updated bibliometric analysis can give an ongoing development in the field. During the 1980s, an average of 45 papers were produced, during the 1990s an average of 83, at the beginning of the first decade of the 21st century quadrupled to 273 and since 2010 an average of 904 articles were contributed in this field.

Keywords: Meditation, Bibliometric Analysis, R Software, Literature Review.

1. Introduction

Meditation is becoming a panacea for today's problem. Day by day anxiety, self-doubt, psychological imbalance, suicidal tendencies, and relational conflicts are also increasing. However, the development of medicines could solve some of these problems to an extent. The doctors and psychologists realized the limitations of such substances in curing psychological disorders. India is considered to be the motherland or the pioneer in the field of meditation and yoga, but in recent days' researchers in the United States (US) realized the importance of it and have been carrying out systematic developments in this field. The researchers realized there is a limitation to human perception, at a time human beings focus on limited information beyond this there is a limitation of the human brain in processing that information. Researchers found the enhancement of focusing our attention on a task can improve one's efficiency and effectiveness. There are a

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number of papers on the positive effect of meditation on emotional well-being. There is an effect of meditation on psychological well-being. In the present time jobs place stress, uncertainty, and instability at the highest level. Stress is harming professional effectiveness and also affecting attention (Smith, 1990). Meditation helps reduce stress and anxiety (Kabat-Zinn, 1992). Stress has various side effects such as depression, disrupted personal relationships (Gallegos *et al.*, 1990), psychological distress, and suicide. (Richings *et al.*, 1986).

2. Meditation and its Impact on Different Aspects of Human Life

Meditation not only helps in reducing stress but also helps in developing a good career in higher education (Shapiro *et al.*, 2011). Some of the papers discuss the transmutation of brain cells because of meditation. Pain, stress, coping, and quality of life comprise the original focus of medical research into mindfulness: (i) decreased perception of pain severity; (ii) increased ability to tolerate pain or disability; (iii) reduced stress, anxiety, or depression; (iv) diminished usage of, and thereby reduced adverse effects from analgesic, anxiolytic, or antidepressant medication; (v) enhanced ability to reflect on choices regarding medical treatments (e.g., the decision to seek a second opinion); (vi) improved adherence to medical treatments; (vii) increased motivation for lifestyle changes involving diet, physical activity, smoking cessation, or other behaviors; (viii) enriched interpersonal relationships and social connectedness; and (ix) alterations in biological pathways affecting health, such as the autonomic nervous system, neuroendocrine function, and the immune system (Kabat-Zinn, 1992).

This review assessed the effects of mindfulness-based stress reduction (MBSR) programs on mental and physical health. The authors concluded that the results suggest that MBSR may help diverse populations deal with clinical and non-clinical problems (Grossman, 2015).

Self-regulation of attention toward immediate experience, orientation toward own experience of the present moment: curiosity, openness and acceptance, introspection, self-observation, self-awareness, non-elaborative awareness of thought, feeling, and awareness, and solutions to traumatic disorder, anxiety disorder, eating disorder, substance use, clinical syndrome (Bishop *et al.*, 2004).

Stress is harming professional effectiveness and also affecting attention. (Smith, 1990). Stress has various side effects such as depression, and disrupted personal relationships (Gallegos *et al.*, 1990). Meditation helps reduce stress and anxiety. (Kabat-Zinn, 1992). Meditation not only helps in reducing stress but also helps in developing a good career in higher education (Shapiro *et al.*, 2011).

3. Research Objectives

The importance of meditation has increased substantially in the 21st century along with other scientific developments. Many leading universities have been contributing to this field immensely. It seems the renowned universities have realized the importance of the field and have carried out several interdisciplinary researches and the contributions are in various domains, like applications of meditation in education, relations, healthcare, work-life balance, etc. As we witnessed in the earlier discussion US universities are pioneers in this field. Almost 50% of the articles were contributed by the US. There are leading journals contributing to the field of meditation and importance of many of them are growing in this field. In the future, stress and tension will increase, and there are a lot of areas opening up for researchers in the field of meditation to give solutions to society.

The objectives of doing the bibliometric analysis in the field of meditation are given below:

a. To determine the top sources of meditation research.

b. To determine the locations and top references of meditation research.

c. To understand the growth and contribution of various sources and authors.

d. To understand the future trend of research in the field of meditation in various fields.

4. Research Methodology and Data

4.1 Bibliometric Analysis

The publications under the search words were collected from the years 1980 to 2020. Major contributing sources are given below. From the below, it can be observed hardly 2 bibliometric analyses were carried out in this field in the past. So an updated bibliometric analysis can give ongoing development in the field.

The bibliometric analysis analyses the statistics of research from a credible source like Scopus or Web of Science. The data we gathered from Scopus from 1980 to 2021. The research articles published in journals, books, and conference proceedings were collected for further processing. The major keywords are Meditation, Yoga, Mindfulness, and Raj yoga.

The following analyses are carried out in this paper: (i) Various Sources of Research in Meditation (ii) Annual Productions of Articles in the Field of Meditation since 1980 (iii) Research in Meditation and Universities (iv) Leading Universities and their Contribution in Meditation (v) Countries and Contribution in the Field (vi) Leading Countries in the Field of Meditation (vii) Corresponding Author's Country, Countries, and the Collaborations in the Work (viii) Source of Meditation Research (ix) Source Growth (x) Bradford's Law (xi) Author's whose Works have been Cited Most (xii) Lootka's Law (xiii) Most Frequent words in the Meditation research (xiv) Word Growth

5. Findings

5.1 Research Objective 1: To determine the top sources of research in meditation.

Table 1 highlights the progress since 1980 of the field the number of works has been consistently increasing, and the importance of this field is consistently increasing with time. With growing stress and economic uncertainty more and more people are adopting the practice of meditation for a healthy life. Among the researchers, the relevance of the field is also growing among the scientific community. In earlier days' the practice of meditation was considered to be blind faith, ritual, or agnostic, now a day people started understanding the benefit of the field and their applications in their professional and personal lives. Researchers like Kabat, Brown, Braer, Grossman, Shapiro, Davidson, Peterson, Lutz, Kirschbaum, Jennings, Khoury, etc have been contributing to this field's sincere emergence. Since 2016, more than 1000 articles have been contributed to this field by various researchers. During the 80s an average of 45 papers were produced, during the 90s an average of 83, at the beginning of the first decade of the 21st century quadrupled to 273, and since 2010 an average of 904 articles were contributed in this field (Figure 1). The importance of meditation has increased substantially in the 21st century along with other scientific developments.

Table 1: Various Sources of Research in Meditation

Description	Results
Main Information About Data	
Timespan	1980:2021
Sources (journals, Books, Etc)	4318
Documents	13912
Average Years From Publication	9.26
Average Citations Per Document	19.21
Average Citations Per Year Per Doc	1.873
Document Types	
Article	9396
Article; Book Chapter	390
Article; Early Access	177
Article; Proceedings Paper	195
Bibliography	2
Book	23
Book Review	629
Editorial Material	475
Editorial Material; Book Chapter	28
Letter	169
Meeting Abstract	619
Proceedings Paper	231
Record Review	50
Review	1188
Review; Book Chapter	8
Authors	28505

5.2 Research Objective 2: To determine the locations and top references of research in meditation.

Research in Meditation and Universities

Many leading universities have been contributing to this field immensely. It seems

Figure 1: Annual Productions of Articles in the Field of Meditation since 1980

Source: Authors' Compilation

the renowned universities have realized the importance of the field and have carried out several interdisciplinary researches and the contributions are in various domains, like applications of meditation in education, relations, healthcare, work-life balance, etc. The various world-renowned universities and their contributions to the field of meditation are displayed in Table 2. Along with the various disciplines of Harvard University, Wisconsin, California, Duke, Toronto, Stanford, Massachusetts, Yale, etc. have been contributing to various domains of this field (Table 2). The research in the field of meditation is not limited to philosophy, religion, psychology, and culture, it has influenced the fields of health, education, science, and technology. The paradox is that even if the field originated from India, not a single Indian University is a leading contributor. It can be observed Harvard Medical University also has taken this field seriously. Most of the universities are from the US. European and Asian universities need to realize the importance of the field to expedite their research in this field. Though Asian countries are arduous admirers and practitioners of this field, US universities have systematically investigated and applied in various domains to get unambiguous results.

Countries and Contribution in the Field

As we witnessed in the earlier discussion US universities are pioneers in this field. Almost

Table 2. Leading Universities and Their Contribution to Meditation

Affiliations	Articles
Univ Wisconsin	334
Harvard Univ	274
Univ Calif Los Angeles	253
Duke Univ	232
Univ Calif San Francisco	206
Univ Washington	203
Univ Penn	179
Univ Toronto	177
Brown Univ	166
Univ N Carolina	160
Stanford Univ	151
Emory Univ	148
Univ Massachusetts	141
Columbia Univ	140
Maharishi Univ Management	136
Univ Minnesota	136
Yale Univ	135
Univ Pittsburgh	134
Harvard Med Sch	133
Univ Michigan	132

50% of the articles were contributed by the US. Most of the publications carried out in the US are a single country production means authors are from the US only (Table 3). Multiple countries' publications are just a fraction of the total publications.

Table 3. Leading Countries in the Field of Meditation

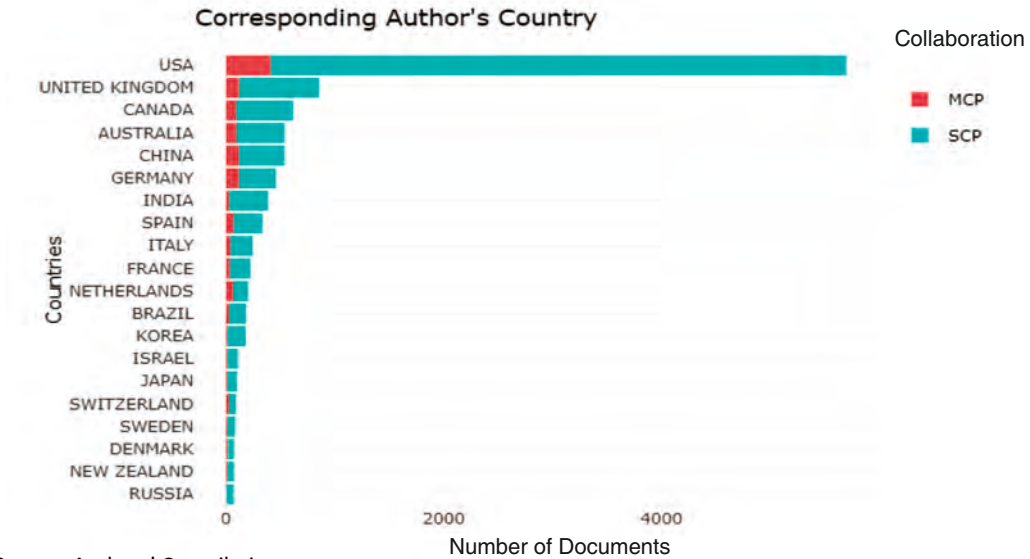
Country	Articles	Percentage
USA	5702	46.61%
United Kingdom	858	7.01%
Canada	618	5.05%
Australia	542	4.43%
China	541	4.42%
Germany	463	3.78%
India	388	3.17%
Spain	336	2.75%
Italy	248	2.03%
France	228	1.86%
Netherlands	204	1.67%
Brazil	186	1.52%
Korea	183	1.50%
Israel	113	0.92%
Japan	101	0.83%

The graphical presentations of MCP (Multiple Countries Publications) and SCP (Single Countries Publications) of various countries are shown in Figure 2.

Countries and Collaborations in the Work

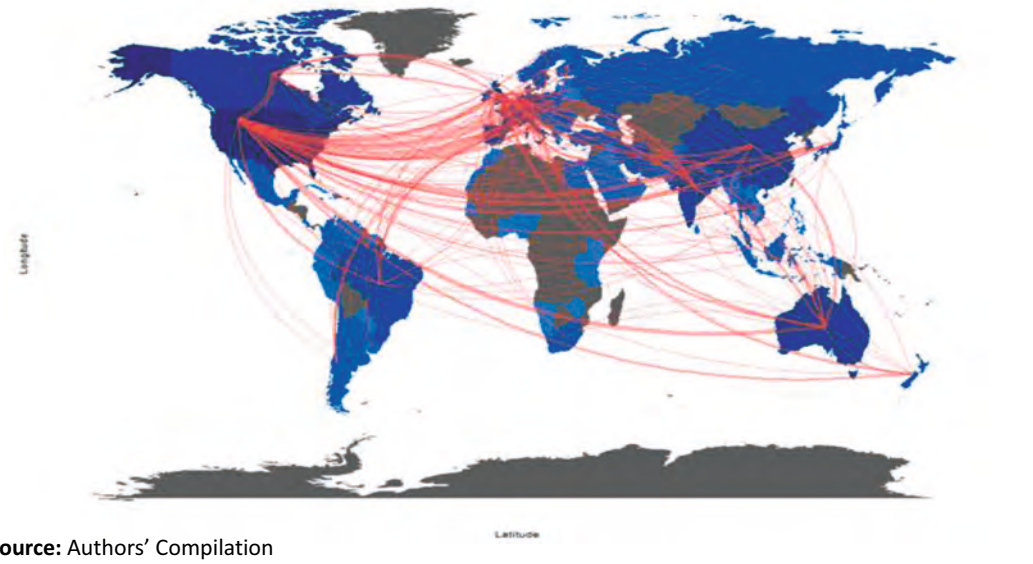
Going through the graph, it can be observed US, and Canada are collaborating on a lot of work with Europe, Australia, and Asian countries. Cross-border ties ensure the cross-cultural exchange of ideas. Figure 3 highlights the collaboration among different countries.

Figure 2: Corresponding Author's Country



Source: Authors' Compilation

Figure 3: Country Collaboration Map



Source: Authors' Compilation

Source of Meditation Research

There are leading journals contributing to the field of meditation and importance of many of them are growing in this field. The journal mindfulness has contributed most and the importance of it has been growing consistently in this field. The top 20 journals in the field as mentioned in Table 4.

Going through the graphical trend of the growing importance of these journals it is obvious the journal named Frontier in Psychology is coping well in this field along with mindfulness. The Journal of Science and Healing and the Journal of Alternative and Complementary Medicine are in a decreasing trend in the field (Figure 4).

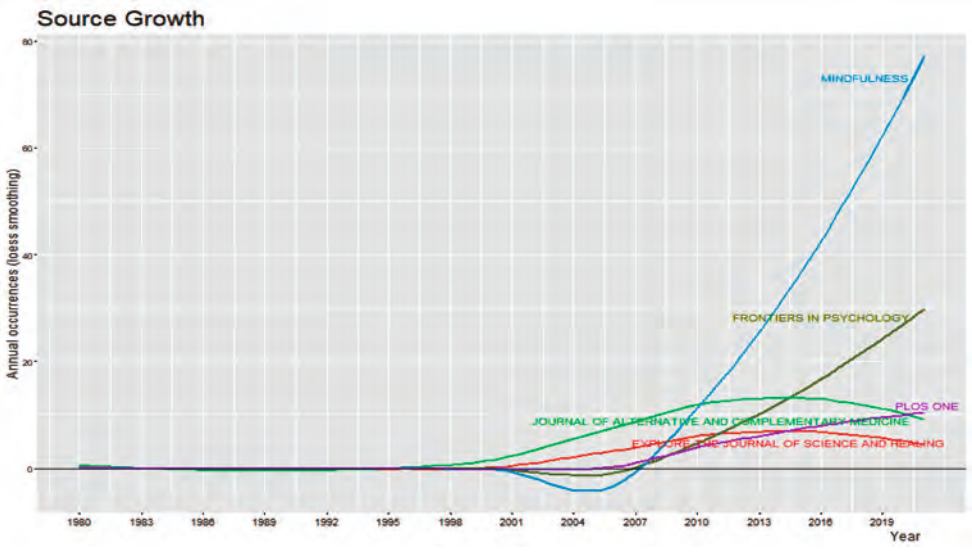
5.3 Research Objective 3: To understand the growth and contribution of various sources and authors.

Meditation as a field of research is evolving and expanding among social researchers. The field has been influencing various managerial studies, as well as in the field of health science. Health practitioners and psychologists have started to recognize this field as scientific, progressive, and authentic. Though the practice of meditation was restricted to religion and spiritual practices with time various scientific studies were carried out in the area of psychological well-being and organizational productivity. With time some of the journals demonstrated remarkable growth and development. Journal of Mindfulness and Psychological Frontiers have been contributing and growing, while many are experiencing stagnation or decline (Figure 4).

Table 4. Sources of Meditation Research

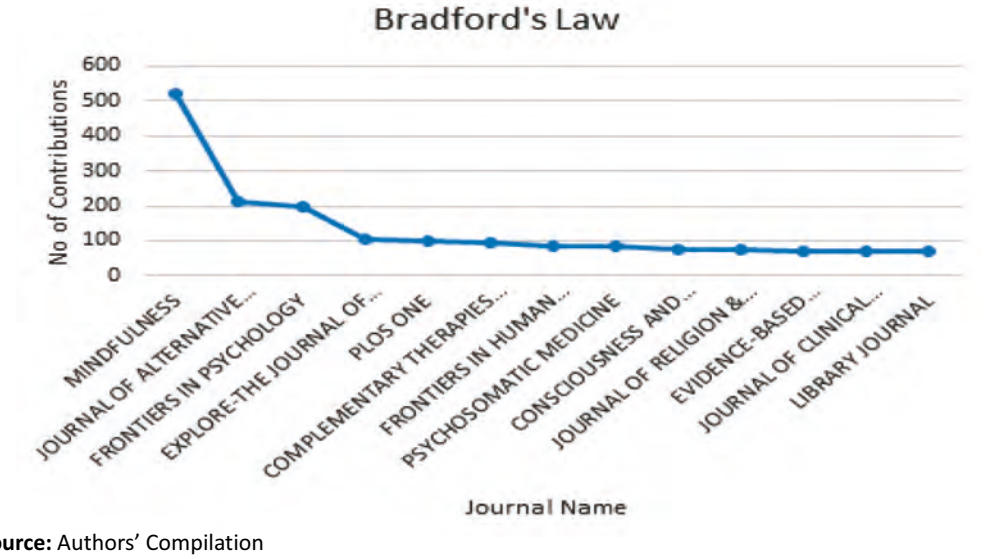
Sources	Articles
Mindfulness	519
Journal of Alternative and Complementary Medicine	214
Frontiers in Psychology	198
Explore-the Journal of Science and Healing	104
Plos One	101
Complementary Therapies in Medicine	94
Frontiers in Human Neuroscience	85
Psychosomatic Medicine	83
Consciousness and Cognition	77
Journal of Religion & Health	76
Evidence-based Complementary and Alternative Medicine	72
Journal of Clinical Psychology	72
Library Journal	68
Psychophysiology	66
Complementary Therapies in Clinical Practice	64
Alternative Therapies in Health and Medicine	63
Applied Psychophysiology and Biofeedback	62
Contemporary Buddhism	61
Religions	58
Behaviour Research and Therapy	52

Figure 4: Source Growth



Source: Authors' Compilation

Figure 5. Bradford's Law



Source: Authors' Compilation

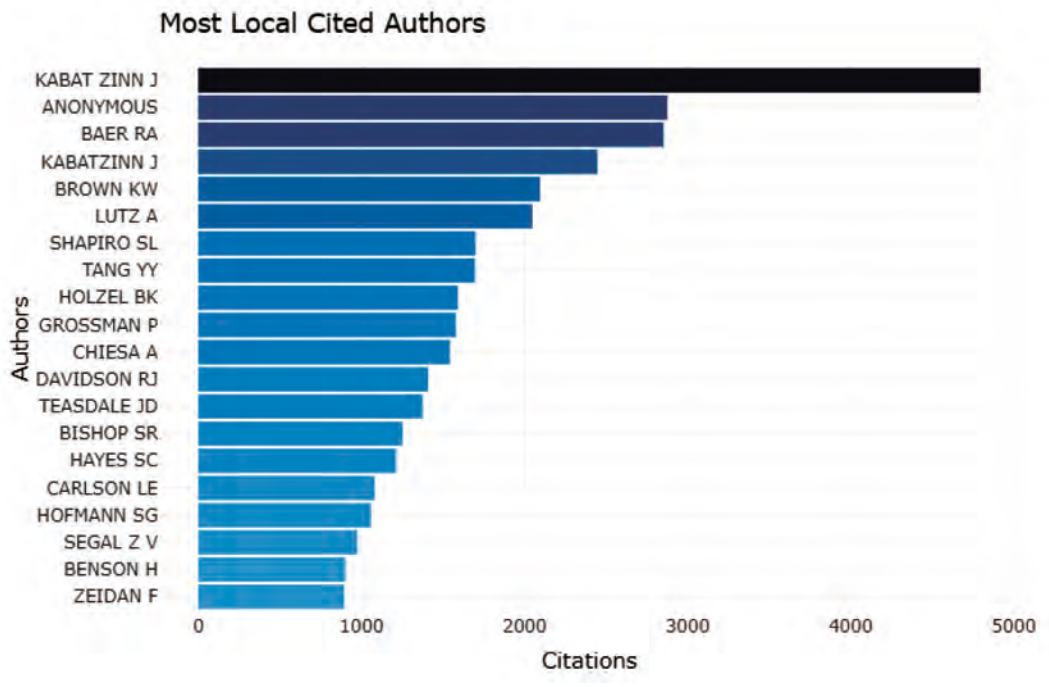
Bradford's law is a pattern first described by Samuel C. Bradford in 1934 that estimates the exponentially diminishing returns of searching for references in science journals. Going through the contribution by different fields, it follows the pattern as suggested by Bradford's law. Going through the contribution by different sources in graphical form, the exponential pattern is quite visible (Figure 5).

In terms of citations, Kabat Zinn is the most influential author in the field followed by Baer, Brown, and Lutz (Figure 6).

The most cited 20 documents contributed by the various researchers are mentioned in Table 3. The author contributed most among the most cited 20 documents is Kabat Zinn and he has contributed 6 papers. Along the Kabat Zinn, Baer RA, Brown KW, Bishop SR, Segal ZV, Grossman P, Lutz A, Shapiro SL, Hofmann SQ, Holzel BK, Teasdale JD, Lazar SW, and Cahn BR are the leading contributors.

Going through the number of documents contributed by the various authors it was found 78.7 per cent of the total 28505 authors

Figure 6. Authors whose Works have been Cited Most



Source: Authors' Compilation

have just contributed one article and 12.2 per cent of them contributed one article and 0.4 per cent have contributed more than 10 articles. Looking into the graphical curve and the fit line it is obvious author's contribution to the field in terms of the number of articles is following Lootka's Law.

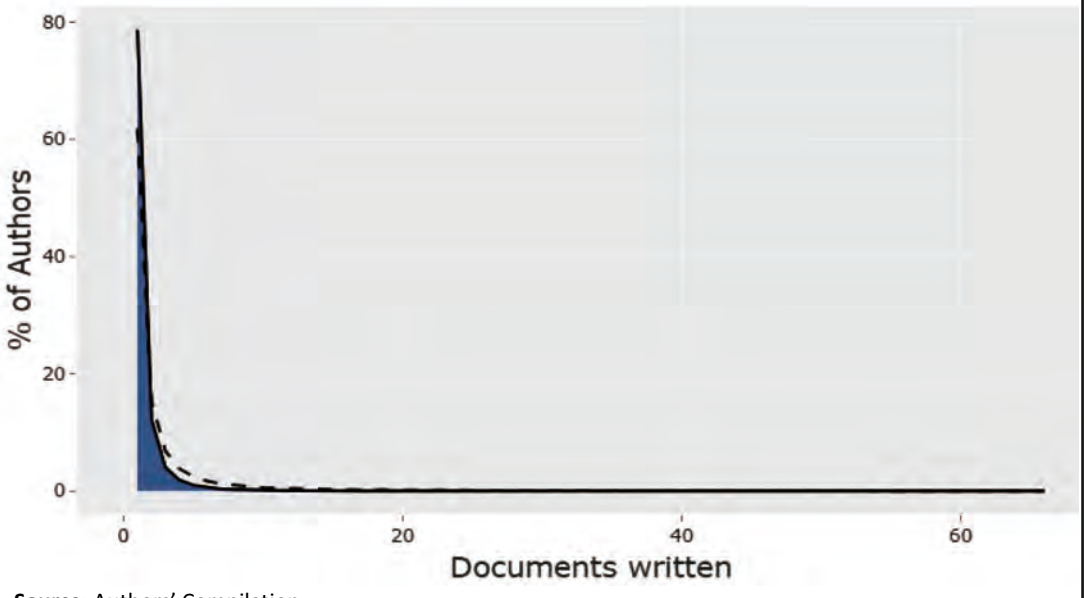
Figure 7 highlights the author's contribution in term of the number of articles by them in the field.

Looking into the past trend of research in the field, a future trend was explored in various fields related to meditation and its applications. This is being carried out by exploring the most frequent words used in the meditation, their growth, and developments with time.

Most Frequent Words in Meditation Research

Going through the most cited words in the research documents, obviously the word "meditation" should be the most repetitive. Besides meditation, the words stress reduction, depression, stress, anxiety, health, therapy, and quality of life are the most frequent words (Figure 8). The researchers found there are strong connection between meditation and stress reduction, depression, anxiety, and health. The researchers also found with the intervention of meditation the quality of life and health of individuals can be

Figure 7: Lootka's law



Source: Authors' Compilation

improved. They are also exploring how meditation can be used as therapy in treating many physical and psychological disorders among patients.

Going deeper through the thematic diagram it was observed there is research connecting meditation with mood, attention, care, efficacy, performance, etc. Meditation and performance in the personal and professional life are the areas of importance in the corporate and professional world.

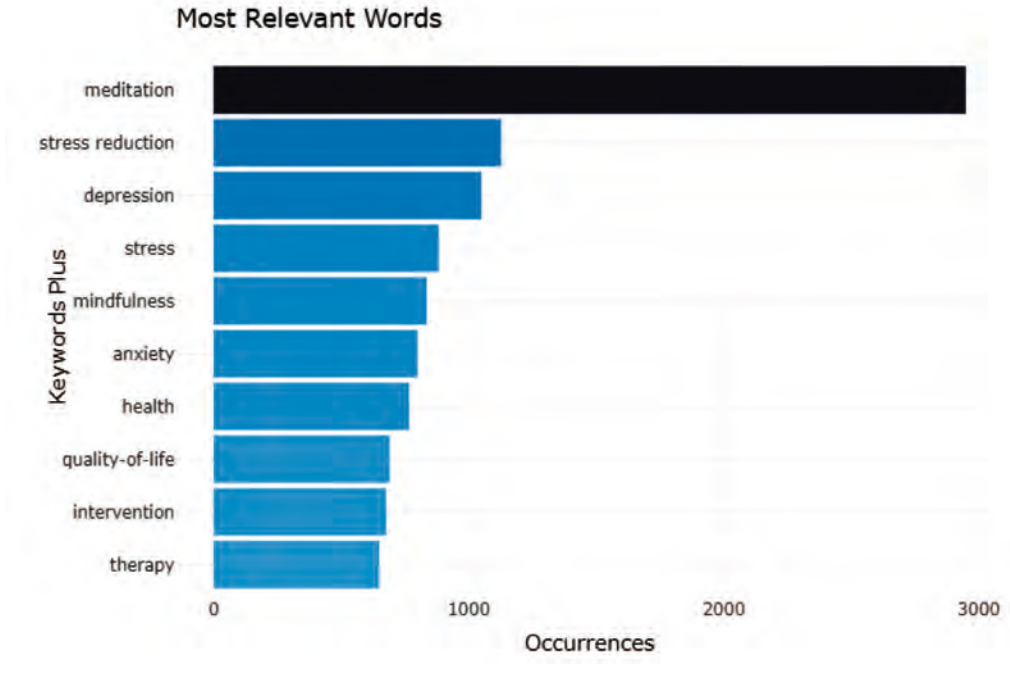
Looking at the growing trend, one can conclude, that the importance of meditation in the reduction of stress, depression, anxiety, and health disorders is growing (Figure 8). To have a healthy and better quality of life people are adopting meditation. Among all the words mindfulness is a kind of meditation drawing the attention of the researchers.

In detail going through the word clouds linkage of the meditations with other concepts is quite clear in Figure 9.

6. Future Trends and Implications

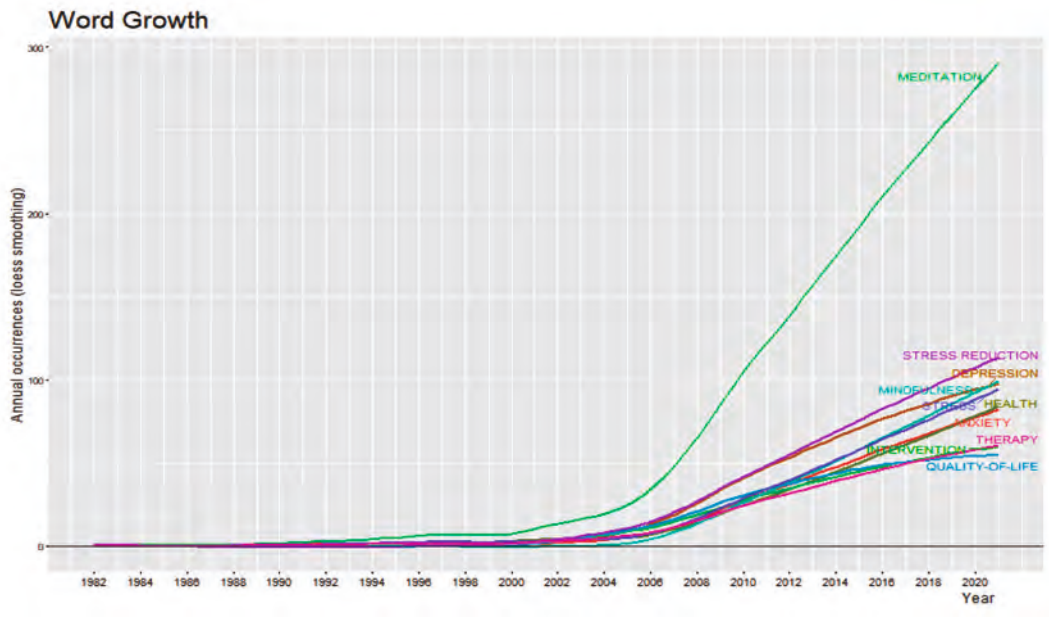
Meditation is one of the most common topics of discussion in the fields of occupational

Figure 8 Most Frequent words in the Meditation research



Source: Authors' Compilation

Figure 9. Word Growth



Source: Authors' Compilation

therapy, clinical psychology, and also in the management stream. With increasing uncertainty, the stress and tensions are increasing within war and conflicts. It has been realized that emotional and psychological well-being are very much required along with the physical and economic health of individuals. A lot of meditation campaigns have been conducted across the globe by various yoga gurus. Still, the field lacks systematic study or research. Specifically, though India is considered to be the birthplace of such practices, hardly any research has been initiated. Looking into the calamities, pandemics, and war there is a dire need for such experimentation and research. The enhancement of focusing our attention in a positive sense can be improved through the positive habits of the practice of meditation. Several types of research have been carried out in this field in the past to understand and explore the utility of its practices in various aspects of life. With time importance of meditation has been increasing to reduce stress and anxiety. Growing uncertainty, work pressure, and economic downturns are making people depressed and stressed. During this time of pandemic, because of death and

devastation stress level has surged to a new level. Meditation's importance in this world is growing. People started appreciating the importance of the utility of meditation in the different aspects of life.

7. Conclusion

This research highlights the importance of meditation in human life and why people opt for meditation in their routine. This research adopted a bibliometric approach to classify the findings in four ways (i) highlighting the top sources of meditation research, (ii) determining the locations and top references of meditation research, (iii) understanding the growth and contribution of various sources and authors (iv) understand the future trend of research in the field of meditation in various field. To explore these objectives this research employed R software with the Bibliometrix package along with the graphical interface Biblioshiny to extract and classify the data, where different Tables and Graphs have been developed to report the status of the research in the domain under study.

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The Evolution of Responsible Tourism Literature in Nordic Countries: A Bibliometric Analysis

Manoj Kumar Kamila[1], Sahil Singh Jasrotia[2] and Shagun Chib[3]

Abstract

The study attempts to uncover a responsible tourism approach in tourism management by conducting a comprehensive bibliometric analysis. PRISMA framework has been used with the Scopus database to build a comprehensive dataset. The inclusion and exclusion criteria checked the research studies thoroughly for duplication in high-ranked journals. The article is used for comprehending responsible tourism concerns through a multidimensional approach like bibliometric analysis and some potential cluster strategies for dealing with such sustainable tourism challenges. The search for a suitable dataset produced 788 documents. The survey results suggested that society's awareness is expanding as more articles addressing these sustainable tourism concerns are published in the Nordic area. The current study helps us understand sustainable tourism and identify new research opportunities. The administrators and policymakers can understand the advantages of responsive, sustainable tourism goals. We only consider scientific publications in English and Scopus as a database. Keyword analysis showed corporate social responsibility as the most prevalent topic, with recent works shifting focus to sustainable development, social behavior, and climate change. This bibliometric analysis and literature assessment can guide future research, including innovative uses in numerous academic fields. The present research has uncovered possible gaps caused by responsible tourism behaviors, which can be looked at for Nordic countries.

Keywords: Bibliometric, Responsible Tourism (RT), Nordic, Scopus, PRISMA.

1. Introduction

The term "Responsible Tourism" (RT) refers to the actions and awareness of all parties involved in the tourism industry that are directed towards environmentally, socially, and economically sustainable tourism (Mondal and Samaddar, 2020). The RT is one

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of the possible approaches to achieving the United Nations' Sustainable Development Goals (SDGs) by the year 2030. It is an effective force that brings together many stakeholders in the tourism industry (Burrai *et al.*, 2019). Responsible tourism provides the local community with the most significant possible advantages and assists the native people in preserving their traditions and environment (Mathew and Sreejesh, 2017; Caruana *et al.*, 2014). Research in this field has grown to encompass a wide variety of viewpoints and orientations per the research community's priorities and interests with the goals they have set for themselves. Others focused on socially responsible consumption traits (Luo, 2018) and tourists' environmental orientation. While some of them studied consumers' attitude that influences RT participation (Frey and George, 2010) and pro-environmental behavior (Zhang *et al.*, 2018), others studied consumers' attitudes that influence RT participation (Frey and George, 2010). Vacationers and researchers have also concentrated their attention on a variety of other stakeholders, including domestic and international tour operators, host communities, government or policymakers, destination marketing organizations (DMOs), non-governmental organizations (NGOs), and marketers.

A recent study found that philosophical parts of responsible tourism have yet to be represented in the concept's true spirit, and a significant portion of its comprehension has remained constrained (Jasrotia *et al.*, 2021b; Burrai *et al.*, 2019; Chattopadhyay, 2016). Researchers in all areas of tourism have concluded that to get a more profound understanding of this topic, they need access to additional data backed up by theoretical foundations and possess greater conceptual precision. A synthesis of research effort becomes essential, as it has been overdue for quite some time when one considers these deficiencies together with the growing body of writing in various areas within this field. This work includes a bibliometric evaluation of the academic works and sketches a future road map in the RT area. Bibliometric is an applied branch of research that provides several indicators that illuminate the cycles and patterns at work within the scientific community. The decisions that may be made and the new information that can be developed are aided by the outcomes of its application to the evaluation of scientific areas, universities, journals, and other scientific aggregations (Kamila & Jasrotia, 2023a; Kamila & Jasrotia, 2023b; Donthu *et al.*, 2021). These kinds of assessments aim to learn about academic engagement in research on a particular subject to determine where the capacities are located, forge and deepen alliances, and collaborate on projects.

Additionally, the research agendas will drive future researchers to develop their work in a relevant direction. This study will aid policymakers, government authorities, disease management organizations, and other

connected stakeholders in sustainably tackling the issue of RT by highlighting the essential areas. In addition, the research helps integrate the literary works that pertain to this field in the Nordic regions.

Some earlier research (Mihalic *et al.*, 2021; Khanra *et al.*, 2021) looked at broad trends and networks in this area, but this is the first bibliometric review that only looks at papers from the Nordic countries. This study gives us new information about the research taking place in this critical area by making a map of responsible tourism papers written by researchers in Denmark, Finland, Iceland, Norway, and Sweden. This study also looks at publications from 1992 to 2021, which gives us a more extended time window to see how the conversation about responsible tourism has changed over nineteen years. This bibliometric review is different from others because it uses keyword analysis to shed light on areas that are becoming more important, such as climate change, business social responsibility, and sustainability. Lastly, the study gives a fresh look at how multinational research partnerships are changing the field of responsible tourism in the Nordic countries. It finds possible partners for future work by highlighting established schools and authors who have written a lot.

Furthermore, this focused bibliometric review adds a lot to what we know about responsible tourist research in Northern Europe. Three main reasons led to the choice of the Nordic countries as the location of this bibliometric study. This is because the Nordic area is seen as a leader in policies and programs for sustainable tourism. Also, looking at research from these countries only gives us new information compared to other bibliometric studies that looked at research from around the world, and a focused study of the Nordic area lets us find patterns of research collaboration within and between these countries that affect the progress of responsible tourism studies in Northern Europe.

This bibliometric evaluation is capable of producing a road map for future study. It contributes to developing a holistic depiction of concerns connected to the accomplishment of "Responsible Tourism." In this current situation, policymakers and organizations may utilize an informative model as a guide to efficiently manage their sustainable growth and research toward responsible tourism. In light of this, the study addresses the research issues that are listed as follows:

RQ1: What characteristics are related to responsible tourism in the research context?

RQ1a. Which Nordic member countries/regions mainly focus on research towards responsible tourism (to know responsiveness)?

RQ1b. Who are the essential contributors who have significantly given attention to responsible tourism development?

RQ1c. What are the key areas and topics of interest in responsible tourism research?

RQ1d. What are the most influential publications related to responsible tourism?

RQ2: How has the research area developed over time for achieving tourism responsively?

RQ3: What are the significant areas of concern of tourism that may be addressed in future research?

2. Theoretical Background

It has previously been documented that the expansion of tourism and the rise of tourist-related commerce has a commensurate degree of effects on companies, the people, biodiversity, and the environment. While analyzing the effects of the most recent COVID-19 on tourism businesses, Dogru *et al.* (2022) concluded that sustainable business practices provide greater resilience to pandemic-like external shocks and that practices also moderate the adverse effects of environmental, social, and governance risks on firm value. In addition to the socioeconomic advantages inherent to tourism, several studies have found a list of negative footprints left by the unregulated and uncontrollable rise of mass tourism.

The rise of tourism affects the economy, society, and the environment. Studies show that uncontrolled mass tourism leaves terrible marks on the environment. This has led to ideas like ecotourism, sustainable tourism, and responsible tourism, all related to the link between tourism and the environment (Nguyen *et al.*, 2020; Jasrotia *et al.*, 2021a). Ecotourism means visiting natural places without damaging them too much, and sustainable tourism means doing things that are good for the environment all along the tourism value chain (Jasrotia *et al.*, 2021b; Stanford, 2006). These ideas come from worries about the effects of tourists on the environment. Sustainable tourism is a broad idea or concept for how tourism can grow. It can only work well if all stakeholders act in a way that is good for the environment (Mohamadi *et al.*, 2020). Responsible tourism is the way of thinking and acting that goes along with healthy tourism. Responsible tourism lessens the adverse effects on the environment, society, and the economy. This sense of responsibility applies to all types of tourism and all funds for tourists (Dogru *et al.*, 2022). In short, sustainable tourism is the big picture or goal, ecotourism is a minor part of small-scale nature-based tourism, and responsible tourism is the way of thinking and acting to make the whole tourism business more sustainable.

The concept and vision to guide tourism growth are either sustainable or ecotourism. Responsible tourism is the matching attitude and conduct displayed by the stakeholders in the tourism value chain throughout the execution phase. It was unanimously agreed that the philosophy behind the sustainable tourism approach is the vitality of the mindset having a focus on the sustainability of the environment, including nature, culture,

society, economy, and society as envisioned in the tourism development planning and process (Mahajan & Bose, 2018; Nguyen *et al.,* 2020; Jasrotia *et al.*, 2021a).

3. Methodology

The collection of current information may be significantly expanded upon by doing in-depth research on relevant articles. In the first place, we use a two-step research strategy to encourage a comprehensive knowledge of the context and multilevel relationships involved in the process of "Responsible Tourism". The search strategy provides a synopsis of the present status of the literature, while the bibliometric analysis illustrates the path that the area of research is moving in the future (Kamila & Jasrotia, 2023b). This study is an explanatory cross-sectional evaluation of academic output subjects relevant to "Responsible Tourism" as a Sustainable tourism expansion. As a result, the Scopus database served as the primary source of data and information, providing broad coverage of the world of scientific journal publication. Bibliometric researchers often make use of Scopus. For the present research, all data collection and analysis, including citation analysis, were gathered until 31st October 2022.

After completing the preliminary literature assessment, we begin compiling a list of the subjects that will be the focus of our inquiry. Then, we restrict our search parameters following our demand, which is responsible for tourism (Figure 1).

3.1 Search Strategy

To improve a complete description of "Responsible Tourism" toward the development of sustainable tourism, we adopted a strategy that consisted of three steps. Access was gained to the Scopus Database using search keywords to discover material relevant to the objective of "Responsible Tourism" (table 1). Because we were primarily interested in Nordic nations, we went through the previously published articles and selected only those that had been penned by at least one author hailing from a Nordic nation. These nations include Denmark, Norway, Sweden, Finland, Iceland, the Faroe Islands, Greenland, and Aland.

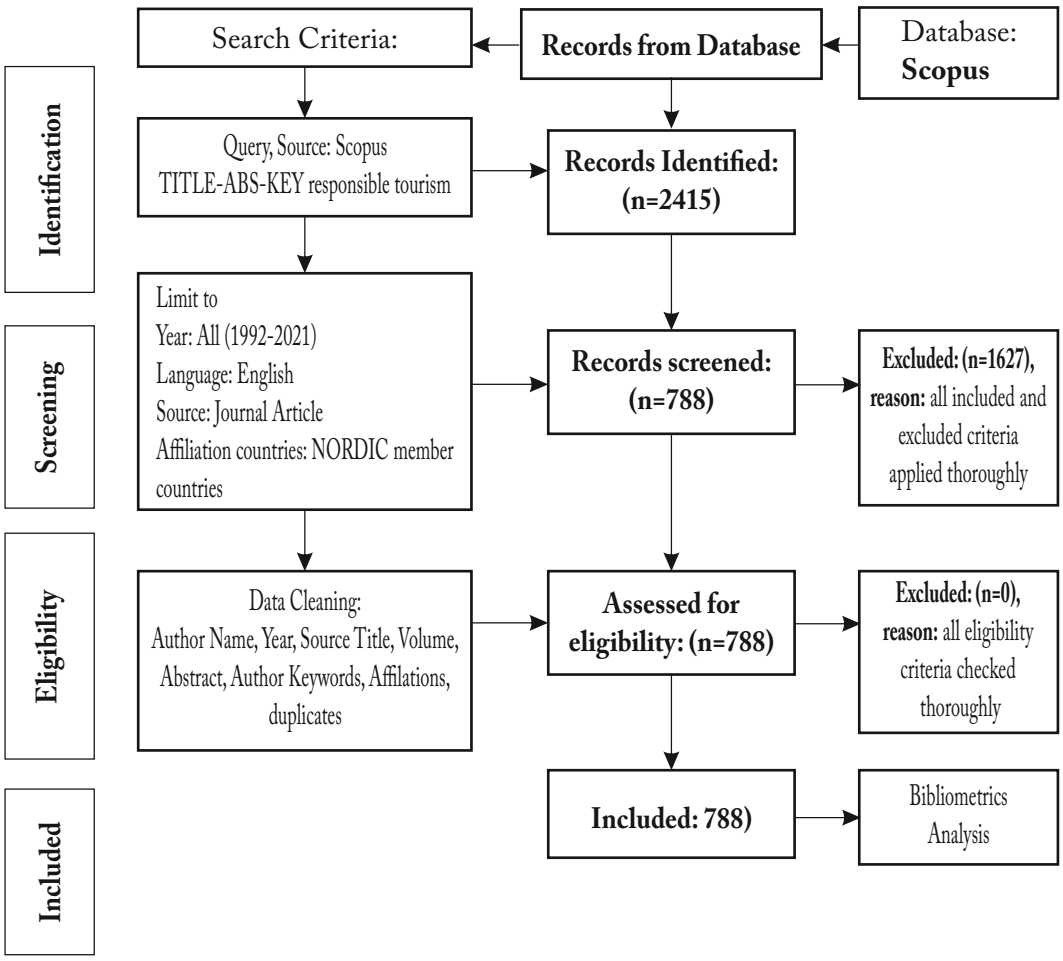
3.2 Primary Keywords and Search Results

The combination of the search query entered into Scopus resulted in a total of 788 articles being extracted from the database. In addition, we concentrate on publications that have been wholly published rather than book chapters, editorials, or conference articles. Table 1 compiles the total number of articles about the chosen keywords. Articles identified include information on the author(s) who contributed to the article, the publication year, the source of the article, the articles' affiliation, and the abstracts.

3.3. Selection Criteria

The mapping of the current literature on responsible tourism as it relates to nations in

Figure 1: Research schema for the bibliometric analysis data determination



Source: PRISMA framework and author's compilation

the Nordic region was the primary focus of the search. The search focused primarily on journal papers written in English with at least one author from one of the Nordic nations. Therefore, items that fell into any other category were not considered. The data was collected from the Scopus database until the recently completed year 2021.

Table 1: Search Condition

Search Criteria Filtrations	Search Criteria	Number of Articles Found
"TITLE-ABS-KEY (responsible AND tourism)"	• Responsible tourism	2415
"responsible AND tourism AND (LIMIT-TO (SRCTYPE, "j")) AND (LIMIT-TO (AFFILCOUNTRY, "Sweden") OR LIMIT-TO (AFFILCOUNTRY, "Finland") OR LIMIT-TO (AFFILCOUNTRY, "Norway") OR LIMIT-TO (AFFILCOUNTRY, "Denmark") OR LIMIT-TO (AFFILCOUNTRY, "Iceland") OR LIMIT-TO (AFFILCOUNTRY, "Faroe Islands") OR LIMIT-TO (AFFILCOUNTRY, "Greenland") OR LIMIT-TO (AFFILCOUNTRY, "Aland")) AND (LIMIT-TO (DOCTYPE, "ar")) AND (LIMIT-TO (LANGUAGE, "English"))"	• Country– NORDIC (Denmark, Norway, Sweden, Finland, and Iceland, as well as the Faroe Islands, Greenland, and Åland)	788
	• Year- 1992 to 2021	
	• Language- English	
	• Source Type- Research Journal Article	

Source: Scopus database and authors' collection

The necessary material was selected with consideration given to issues relating to the application of responsible tourism as well as inclusion-exclusion criteria. The essential progressive characteristics of inclusion and exclusion are outlined in Table 2.

3.4 Quality Assessment

The study is supported by full scientific articles that have been peer-reviewed. To keep the quality of the standard review process consistent at all times, any instances of duplication were meticulously scrutinized.

Table 2: Inclusions and Exclusion Criteria of the Study

Standards for Paper Selection	Criteria for Inclusion	Criteria for Exclusion	Justification for Inclusion-Exclusion
Language	English	Rest all languages	The researchers and the substantial majority of readers comprehend English.
Year	1992 to 2021	Publications before 1992, Not in the Scopus Database	The preponderance of research was conducted during this time, and studies into instances after 2022 are ongoing.
Open access	All	No Exclusion	Every document was necessary.
Author Name	All	No Exclusion	Prejudice on the author's grounds was unreasonable.
Subject Area	All	No Exclusion	This structure did not violate the assortment criteria.
Keywords	All	No Exclusion	The keywords needed for the investigation.
Publication Status	Final	Yes Exclusion	It was necessary to include fully published documents
Source Title	All	No Exclusion	It was necessary to append all of the documents. All of the journal titles were moderately relevant.
Affiliation	All	No Exclusion	This structure did not violate the assortment criteria.
Funding Sponsor	All	No Exclusion	This structure did not violate the assortment criteria of funding sponsors.
Country	Nordic member countries	Yes Exclusion	Others were irrelevant since we focused only on Nordic countries. Nordic country's publication has significance.
Source Type	All	No Exclusion	Others were irrelevant since they were limited to journals.

Source: Authors' Collection

Before moving on to examine the articles' contents, the articles' abstracts were subjected to a rigorous level of scrutiny so that the quality and application of the academic material utilized in the review process could be verified. At a later time, each study report was scrutinized in great detail. Following an examination of each article regarding the inclusion and exclusion criteria outlined above, we carried out a bibliometric analysis on a total of 788 publications.

3.5 Data extraction

In the data extraction phase, 788 articles were selected and the characteristics extracted were:

i. Articles must be original peer-reviewed research papers.

ii. The article must be in the English language.

iii. Extracted articles were published from 1992 to 2021; the data extraction date was 31st October 2022.

iv. Minimum one contributing author from Nordic countries.

4.Analysis

4.1 Overall Publication Outputs and Analysis

This part presents the publication year and the structure of the previous study, which can be seen in Table 3. The uppermost studies with the following format (Table 3) were published between 1992 and 2021, with the most significant number of papers totaling 151 in 2021 (Table 3). To keep the reliability and originality of the study intact, we decided not to include more publications for future research. We excluded additional publications like conference papers, book reviews, and book chapters.

Table 3: Year-wise Publication

Year	Articles
2021	151
2020	90
2019	61
2018	55
2017	54
2016	42
2015	38
2014	33
2013	23

4.2 Prominent Countries/Regions and Their Collaboration Network

To accurately depict the geographical scope of the papers, our research focused on the key nations and regions. Table 4 below enables us to access the most prominent nations and areas by utilizing 'Bibliometrix and Biblioshiny' and gives us comprehensive information about these locations. The most significant number of overall publications in this list was produced in Finland, with 405*

Table 3: Year-wise Publication

Year	Articles
2021	151
2020	90
2019	61
2018	55
2017	54
2016	42
2015	38
2014	33
2013	23

total. Publications from other nations or areas include those from Sweden (403), Norway (360), and the UK (201), and there is considerable apprehension among the researchers that can be proven to boost tourism responsively (Table 4).

The publication trends in different parts of the country are displayed in Figure 2, which focuses on the most productive nations towards responsible tourism. Figure 2 displays the national collaboration map of publications in notable locations, with a minimal parameter of a minimum of one edge being chosen. According to the findings of the research, Norway has published 28 articles with Germany and 26 articles with the United Kingdom, Sweden has published 25 articles

Table 4: Prominent Countries/Regions and Collaboration With Nordic Member Countries

Region	Freq (TP)
Finland	405*
Sweden	403
Norway	360
Uk#	201
Usa#	184
Denmark	180
Spain	165
Italy	138
France	132
Australia	116
Germany	113
Netherlands	100

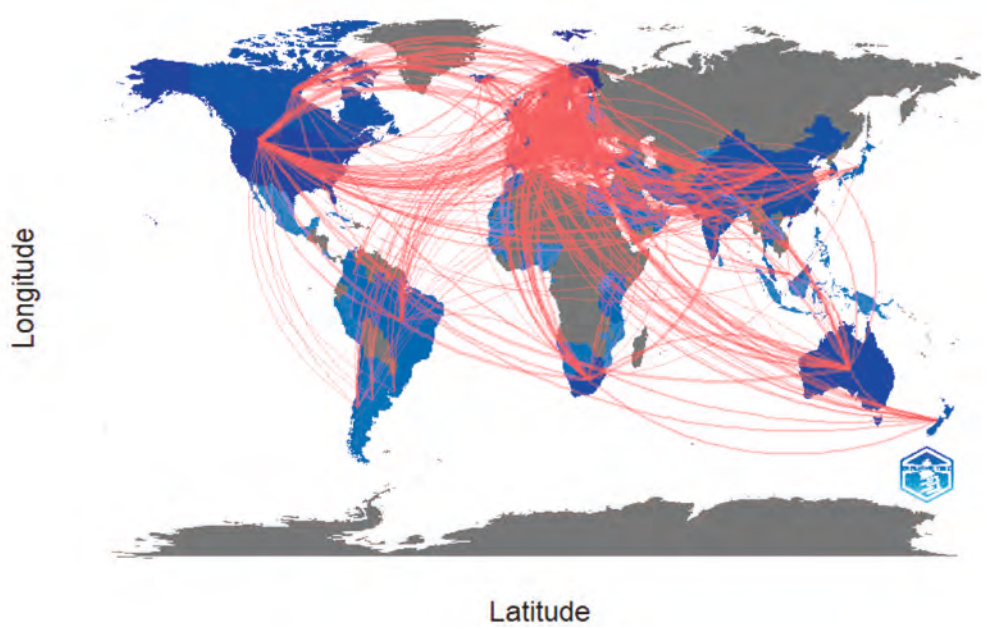
*Note: The above data with * indicates the most significant number in the ranking and TP=Total publications, and # indicates collaborating author with Nordic countries.*

with Germany and 25 articles with the United Kingdom, Norway has published 24 articles with Spain, and Sweden has published 24 articles with Norway and 24 articles with USA (Table 5).

4.3 Prominent Journals

Because there are so many articles related to the effective implementation of responsible tourism, we focus the majority of our research limited to a minimum of one contributor from

Figure 2: Collaboration Network Across the Globe



Source: Scopus Database; Bibliometrics; Biblioshiny Tools.

Table 5: Frequent Collaboration Work Among Countries/Regions

From	To	Frequency
Norway	Germany	28
Norway	United Kingdom	26
Sweden	Germany	25
Sweden	United Kingdom	25
Norway	Spain	24
Sweden	Norway	24
Sweden	USA	24

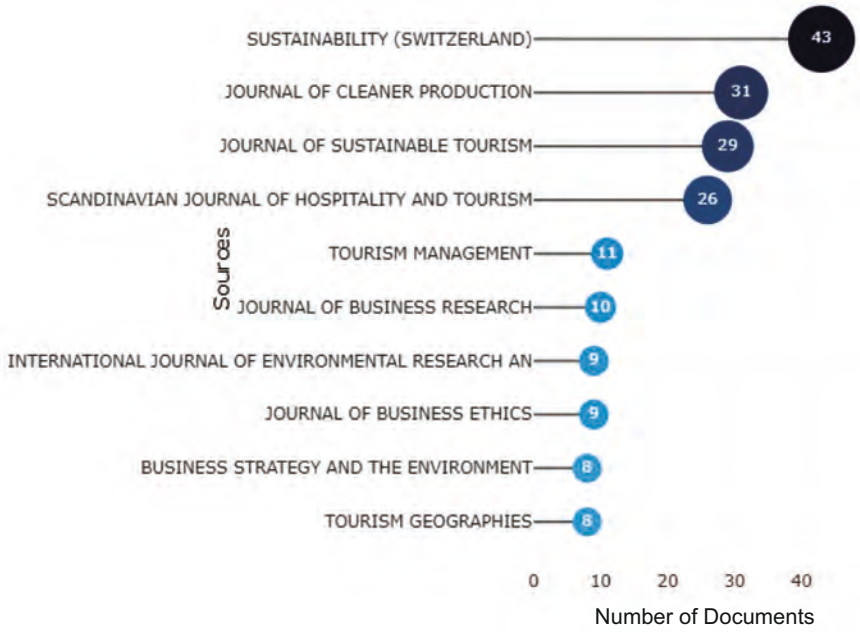
Source: Scopus Database; Bibliometrics; Biblioshiny Tools and Authors' Collection

Nordic countries. Our research, in particular, is predicated on the 788 papers found in the Scopus database. The magazine Sustainability from Switzerland contains the most articles (43*) pertinent to our research. The Journal of Cleaner Production (31) and Journal of Sustainable Tourism report that the demand is growing every day with the contribution of 29 articles. The most significant publications in responsible tourism are displayed in Figure 3.

4.4 Highly Cited Publication / Most Influential Articles

To provide an accurate picture of the field, this

Figure 3: Most Influential Journals Related to Responsible Tourism and Nordic Countries



Source: Scopus Database; Bibliometrics; Biblioshiny Tools

section analyses the research that received the most citations. Table 6 provides a full listing of these best works for your perusal. This entire article uses the global citation system for all of its citations. The piece written by Kate Klonick , published in Harvard Law Review in 2018, has received the most citations, totaling 173*. The fact that multiple publications originating from the same area of study interest have been recognized by scholars worldwide indicates that the work has only just recently started to make an influence (Table 6). References like these that are well-cited are available for future academics to study to discover lucrative research routes.

4.5 Trending Topics and Keywords Co-Occurrences

Figure 4 illustrates how the subject of the research trends is brought to the forefront of this work. The keyword co-occurrences of these authors were used to generate trend themes; the minimum word frequency required to generate a trending topic was five, and each year's trend subject required a word frequency of 10 (Figure 4). In this particular research, the years 1992 to 2021 were considered. There were relatively few

Table 6: Highly Cited Publications

Paper	Total Citations (TC)	TC per Year
Klonick K, 2018, Harv Law Rev	173*	34.60
Kovács G, 2008, J Clean Prod	160	10.67
Ghobakhloo M, 2020, J Manuf Technol Manage	126	42.00
Syvertsen T, 2020, Convergence	71	23.67
Conversi D, 2012, J Ethn Migr Stud	70	6.36
Ursell Gdm, 2001, Journalism	70	3.18
Segars Ah, 2001, J Manage Stud	68	3.09
Jayaram D, 2015, J Econ Finance Adm Sci	59	7.38
Lobschat L, 2021, J Bus Res	58	29.00
Saarikko T, 2020, Bus Horiz	55	18.33

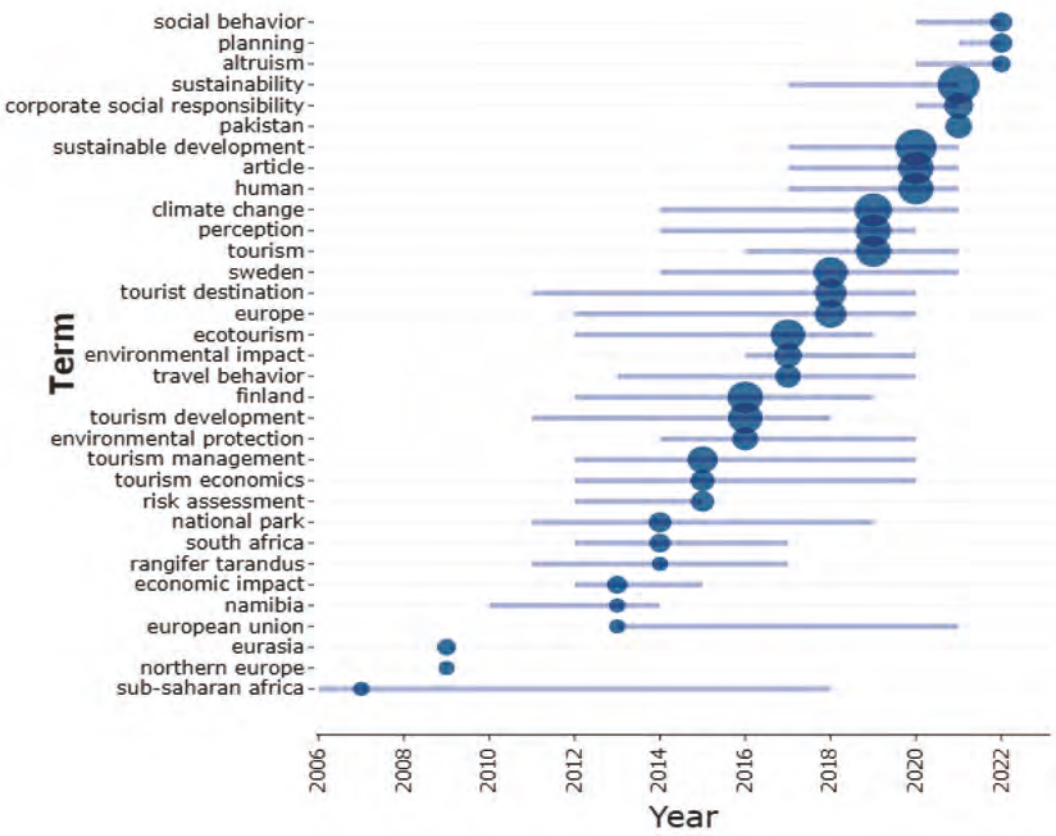
*Notes: Data with * represents the largest number in the ranking. TC = Total global citation number*

conceptions of responsible tourism behavior and activities in the early phases. The journey in 2006 focused on region-specific and progressed progressively towards sustainability in 2021.

4.6 Keywords Co-Occurrences and Clustering by Coupling

The process of grouping objects with many similarities is known as data clustering. In other words, it is gathering information in one location related to the same field. The bibliometrix-biblioshiny cluster network analysis software was utilized in this investigation to facilitate the data clustering process. In bibliometric, the unit of analysis was Documents, and the system specified specific parameters for the analysis, such as the minimum cluster frequency being 5, the coupling being assessed by References, Impact being measured by Global Citation Score, Cluster labeling being done by Keyword Plus, etc. (Table 7). According to the findings, research in group 3 that focuses on "ecotourism, tourism development, and sustainability" has the most potential to contribute to the successful implementation of responsible tourism within the scope of the research area for tourism in Nordic countries (Table 7). In addition, the frequency result demonstrates that "climate change, Finland and Europe" is the most frequently used in academic and research literature on responsible tourism. Several academics

Figure 4: Frequently Used Terms Across Time



Source: Scopus Database; Bibliometrics; Biblioshiny Tools

pointed out that achieving sustainable tourism with the adoption of climate change measures can be a difficult task to accomplish.

5. Results and Interpretation

The current research examines 788 different journal publications. The steps in selecting studies are broken down and described in Figure 1. Even though the literature searches conducted across the various databases and search engines produced a total of 2415 records in the Scopus database, 1627 of those records were excluded because they did not meet the search criteria in their titles, abstracts, keywords, and/or any other relevant criteria. The remaining 788 articles for the bibliometric analysis were meticulously picked using biblioshiny-bibliometrix: An R-

Table 7: Clustering by Coupling

Label	Group	Freq	Centrality	Impact
sustainable development - conf 48.5% sustainability - conf 41.9% tourism - conf 34.9%	1	216	0.128041599	3.082563087
climate change - conf 83% Finland - conf 60.9% Europe - conf 77.4%	2	235	0.115127403	2.275788525
ecotourism - conf 59.5% tourism development - conf 43.9% sustainability - conf 21.6%	3	156	0.133989465	3.951689839
sustainability - conf 21.6% corporate social responsibility - conf 66.7% human - conf 31.8%	4	181	0.134727726	2.408280463

Source: Bibliometrics

tool for comprehensive data analysis with the Scopus data. According to the statistics presented in the article, there is currently a significant concern for responsibility in the tourism industry, and several nations are working toward adopting responsible tourism with the assistance of several partners. In addition, we discovered that a number of the Nordic states are now seeing an increase in the frequency of general talks on the practical implementation of responsible tourism and its objectives. On the other hand, in the 21st century, concerns regarding sustainable tourism have emerged as an uneasy state of affairs regarding the world's ability to sustainable development. The comprehensive evaluation of the relevant literature reveals several additional obstacles that must be overcome to meet sustainable tourism objectives. According to the regional analysis, Finland is the country that has made the most of the 405* academic contributions that are connected to our research on responsible tourism (Table 3). In work done in partnership, academics from Norway and Germany have the most significant number of 28 projects they have worked on jointly (Table 5). As seen in Table 5, several international communities are working together towards sustainable tourism. The researchers concentrated on region-centric in the earlier stage of responsible tourism, which took place in 2006. It then moved on to climate change, and more recently, there has been a massive concern for sustainable tourism management in 2021 (Figure 4).

6. Discussion

The bibliometric study "yields a sound appraisal of previous and present research" and "may serve as a building stone for future methods" (Gast *et al.,* 2015). The analytical clusters are displayed in Table 7. Responsible tourism aims for sustainable tourism development in all its forms. Smooth completion requires cooperation across society, organizations, nations, governmental authorities, and people. Biblioshiny was utilized for bibliometric analysis in this work to uncover obstacles to reaching sustainable tourism through responsible tourism. With the NORDIC countries in mind, we collated scholarly material on responsible tourism and its relevance. Until we make significant discoveries, collecting papers will not help. To perform our research, we checked the author, the origin, and the nation or region of publication.

To answer RQ1, it was found that 788 research articles (with at least one author from the Nordic countries) were made for responsible tourism (Table 2). Table 2 of this work shows our study's implicit inclusion and exclusion criteria. So, RQ1 has been partly answered. To look at RQ1a, the country-by-country research results showed that Finland has the most research contributions of any Nordic member country, with 405 publications, either done alone or with help from other countries (Table 3). The RQ1c was looked at to determine who made the most critical partner contributions to the growth of the responsible tourism literature. It was found that Norway has the most research papers about responsible tourism, and they primarily work with Germany (Table 3; Table 4). Also, the most significant contribution is by Kate Klonick, 2018, which has been cited 173 times (Table 6). To look at RQ1c, we looked at the topics/keywords used extensively in responsible tourism research and how they have changed over time. It was found that "corporate social responsibility" is the most used term over time, and sustainable development could be the next big area of interest for the researchers (Figure 4). Over time, more and more research has been done on responsible tourism towards sustainable tourism. This study looks at how Klonick (2018) (Table 6) became the most important research paper with 173 citations. Also, between 1992 and 2021, most research articles about reaching sustainable tourism goals were published in Sustainability (Switzerland) (Figure 3). So, RQ 1d has been answered. To answer RQ2, we looked at year-by-year data and terms used over time. Research outcomes improved from 2013 to 2021 (Table 3). To reach the SDG 2 goal, there are also different ways to focus, such as on people, places, food, climate, etc. (Figure 4; Table 7).

To answer RQ3, the study results suggested that responsible social behavior and climate change could be a problem for reaching sustainable tourism. Also, the analysis shows that studies focusing on responsible tourism started with a region-centric approach,

focusing on nations and their economic well-being. Studies on sustainable tourism have changed, and new studies now focus on responsible social behavior, especially after the COVID-19 pandemic in 2020. Most studies in the area after 2020 will be about sustainability, altruism, planning, and social behavior (Figure 4).

7. Implications

7.1 Theoretical Implications

This bibliometric analysis looks at some of the most important parts of responsible tourism research, such as the authors who contributed, the topics that were looked into, and the pros and cons of the current literature. It is important to understand the links between places and problems that need to be solved by working together. This helps us understand sustainable tourism in a more complex way and opens up new study areas that might be useful. Researchers, businesses, governments, and people can all be helped by this study to produce more scientific work. Even though the study was mostly about the Nordic countries, the results have effects all over the world. By showing important books, famous authors, and topics that haven't been looked into much yet, mapping study networks and trends helps future research around the world. The change over time of these terms shows how topics like corporate social responsibility are becoming more popular and useful in many situations. Problems with research, like regional silos, happen everywhere. This study shows how to use bibliometric methods to evaluate a group of works in a planned way. Tourism scholars all over the world can use this method to gather and organize ethical dilemmas and responsible tourism ideas from different areas. This study wants to speed up research and practice in responsible tourism around the world by highlighting important work, people, and groups.

7.2 Managerial Implications

The results of this bibliometric study can help shape policies and practices for responsible tourism around the world. It gives officials around the world information that helps them make better strategic plans by showing how themes and clusters are connected. Responsible tourism that is sensitive to different cultures, industries, and countries is good for everyone. To figure out if something is possible, officials everywhere need to know about the problems that come up when trying to put it into action. What happens in the future of each study cluster affects everything else? It makes sense to think that responsible tourist scholarship will grow a lot around the world. Output is likely to go up in all situations. Tourism scholars around the world can use bibliometric methods like the ones shown here to make sense of large bodies of writing on a wide range of topics. Comprehensive summaries are possible when you read and understand a lot of different works. This research shows that bibliometrics can be used to map important topics and

works in a small body of literature. Researchers and officials around the world can use these kinds of methods to quickly look at how responsible tourism knowledge is made in other places. This speeds up decision-making based on data so that responsible practices can be used all over the world.

8. Limitations of the Study and Future Research Directions

The current study includes a few apparent flaws that must be addressed in terms of the examination of theory. The selection criteria may have introduced some bias into the dataset because they were drawn from the Scopus database. Because scholarly publications written in English comprised our investigation's principal focus, we could not consider any other study, even if it would have brought novel and intriguing insights. The key findings of this bibliometric study and literature review can be applied to lead future investigations, including some creative uses in several academic disciplines.

Surprisingly few comprehensive literature reviews exist, even though research associated with sustainable tourism has expanded substantially throughout the past few years, both in terms of the depth and breadth of coverage as well as the number of publications in academic journals. The unclear and contested description of the breadth of executive problems associated with the responsible tourism concern is one of the hurdles that must be overcome. Another difficulty is selecting which contributions to the topic should be seriously considered. Future research ought to broaden the scope of this investigation and improve its results based on the critical insights gleaned from this analysis by collecting more information from other relevant scientific databases, such as Web of Science, Google Scholar, PubMed, and EBSCO, etc. This should be done to take into account the findings of this analysis. We think that by bringing attention to the application-based challenges surrounding sustainable tourism, academics, and academicians will pay greater attention to the rapidly changing and technologically-focused society. In addition, future scholars have the opportunity to do a bibliometric study on responsible tourism because of its direct connection to sustainable tourism. Society can fulfill its objective of improving a sustainable tourism atmosphere if it raises awareness of responsible behavior. In addition, the purpose of this study was to increase awareness about the accomplishments achieved in this field of study as a result of its execution. This study aims to increase awareness of the ethical challenges associated with responsible tourism while also broadening the scope of prior studies on the issue. Furthermore, the research was carried out to broaden the reach of previous inquiries in the field.

9. Conclusion

The current study conducted a bibliometric analysis on the Scopus database involving

Nordic countries, the current research aimed to provide an understanding of the past, present, and future research directions in responsible tourism towards sustainable tourism. This understanding was intended to be provided to assist in achieving the goal of academic development in tourism research. Throughout the course of the analysis, we brought to light the fact that the area of SDG2 involves a wide variety of questions relating to responsible tourism, as well as sustainability, environmental protection, sustainable tourism management, climate protection, altruistic behavior, and environmental concern, amongst other things in the Nordic region. The survey results suggested that society's awareness is expanding as more articles addressing these sustainable tourism concerns are published in the Nordic area. This is in response to the need and problems for sustainable tourism management and responsible tourism in today's world. Research conducted on responsible tourism lays the groundwork for individuals' behavioral actions that may participate in social activities and serve as a basis for individuals' actions. The present research has also uncovered possible gaps caused by the fact that responsible tourism behaviors are further looked for in the Nordic countries.

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