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Risk Assessment Using Business Intelligence Framework for Organizations: A Systematic Literature Review

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Abstract

Today many organizations are facing different kinds of risks as they are migrating towards new technologies. Risk assessment is one of the methods that were developed to help with identifying, assessing, and managing risks. Several studies have been conducted regarding risk assessment and business intelligence, however few studies have been conducted on how both can be integrated and use. A systematic literature review is conducted to understand the importance of risk assessment and business intelligence for organizations. Due to the relevance of BIS and the need for risk analysis before development and implementation, there is need to critically examine literaure to understand what has been done and the gap that exist for future researchers to implement. Therefore this study use the Systematic Literature Review methodology to collect 125 academic publications from over 6 academic, business and research databases for review. Inclusion and exclusion criteria were applied to the papers proning them to 65 and when quality assessment were applied, the total paper obtained amounted to 25 which were eventually used for the review. The results obtained from the review study showed that although there are much publication related to business intelligence and risk assessment, most of them did not incorporate quality assessment, rigorous testing, creation of new analytical tools, application of AI, and deep learning algorithms into developing their business intelligence systems. Future research focus areas resulting from this study were also highlighted in the conclusion session of this study.

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A. Introduction

Risk assessment carried out using business intelligence techniques can be applied in different kinds of industries such as construction[1, 2], banks [3], insurance sector [4], and healthcare [5], educational institutions etc. Risk assessment methodology consists of five steps which are identifying, assessing, managing, monitoring, and reporting the risks[6] like shown in figure 1.

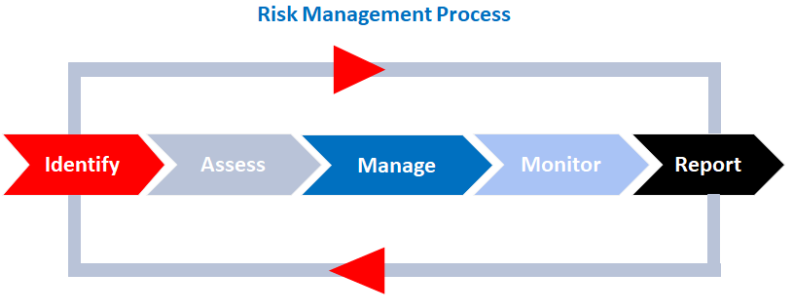

Figure1: Standard risk assessment methodology [MMH]

Although according to Wilhelmsen and Ostrom in [7] there is no major rule of how a risk assessment should be performed as it depends on the business or organization. These organizations use risk assessment as their defence mechanism against various types of risks such as pure risk, business risk, project risks, operational risks, technical risks and political risks [8]. Addressing these various types of risks as a risk manager to different stakeholders of the organization can be a challenging task, as there are many reports and documents involved. Several studies have been conducted to elaborate each and every step of the risk assessment process however, there is limited research on to integrate risk assessment with business intelligence tools and techniques to simplify these challenging tasks faced by risk officers and managers.

Data from both internal and external sources is gathered as part of the business intelligence used in risk assessment to identify risks using predictive analytics as it aids in the diagnostic assessment so that plans can be put in place for optimum resource allocation and maximum performance efficiency. Employing such technologies for effective risk management would undoubtedly aid businesses in effectively achieving their desired goals and objectives[9].

Business intelligence, also known as BI, uses technology to give organizations the precise and timely information they need to make wise decisions. Considering this, there are four essential components of BI which are data gathering, analysis, reporting and knowledge transfer[9]. There are several ways to integrate business intelligence with risk assessment. The authors in [10] showed an efficient strategies that can be used to connect risk assessment with business intelligence strategies such as using AI during data management. The focus of this research is to analyse existing research that have been published within the global research community for the past 10 years on risk management and business intelligence frameworks with those that have integrated risk assessment with business intelligence so that a single compendium can be available for researchers to access containing summaries

of research in the past coupled with the present and a direction for future research that are critical to sustaining the continous application of risk management and BI for business sustainability . At the end of this research, various recommendations will be proffer to business analyst as well as information systems analyst on the best way to apply frameworks for risk assessment in a growing technological world. The framework will help organizations to conduct risk assessment while utilizing business intelligence tools and techniques therefore contributing to the reduction of risks facing these organizations.

This research paper is organized as follows. Risk assessment process and document automation is discussed in section A. Section B provides the research methods used with regards to the search strategy approach, paper relevance and selection, quality assessment process, data extraction and data synthesis. Section C discusses the results while section D give the conclusion and future trend.

1. Background

1.1 Risk assessment process definition

The risk management process is a framework for the actions that need to be taken to minimize the risks faced by organization. There are five basic steps that are taken to manage risk; these steps are referred to as the risk management process and entails the following five steps:

1. **Identifying the risk:** The first step to managing risks and involves detecting the risk source and identifying the type of risk as shown in figure

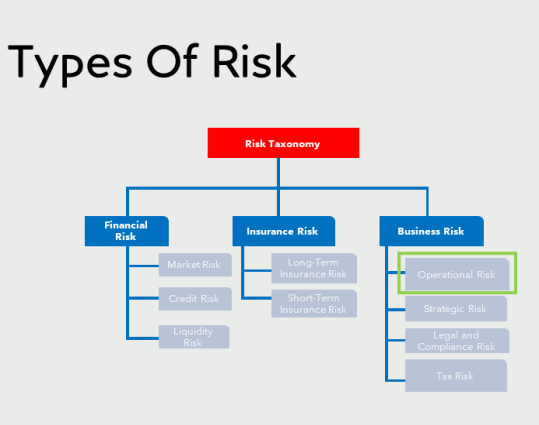

Figure 2: Types of risk faced by organisation.

Risk identifications can be carried using Checklists, Regular meetings, issue logs, behavioural models, diagramming approaches etc [8, 11].

2. **Assessing the risk:** Critically examining the possible risks[12]. Naturally, not every risk event that is discovered is of similar importance. Red zone are dangerous and considered to be very significant. They need special consideration. Green zone risks are those that are not substantial at all,

while yellow zone risks are those that are somewhat significant and call for caution as shown in figure 3.

A risk matrix combines the two components of a risk - likelihood and impact into a single table for risk impact assessment as shown also in figure 3.

Likelihood \ Impact	Negligible	Minor	Moderate	Significant	Severe
Very Likely	Low Med	Medium	Med Hi	High	High
Likely	Low	Low Med	Medium	Med Hi	High
Possible	Low	Low Med	Medium	Med Hi	Med Hi
Unlikely	Low	Low Med	Low Med	Medium	Med Hi
Very Unlikely	Low	Low	Low Med	Medium	Medium

Figure 3: 5x5 Risk Matrix [13]

3. **Managing the risk:** After identifying and assessing potential risks, the next stage is to create strategies and plans of action to control or lessen the impact of such risks. There are numerous methods for managing risks namely: Risk avoidance when for example, the project connected to high impact risk are avoidance avoided, cancelled, or abandoned while risk reduction or mitigation involves taking steps to lessen the possibility of a risk materializing or to lessen its effects if it does materialize. According to [12], risk can be handled by carefully instituting controls to reduce the risk level and then continue to use the system; reduce the negative effect of the risk; reducing the likelihood of loss arising from occurrence of the risk; transfer the risk through insurance or via contract and accept the risk and carry on as if the risk did not occur. A risk mitigation action points was designed by [12] as shown in figure 4 with a "YES" to indicate when to implement control measures that mitigate risk in a project.

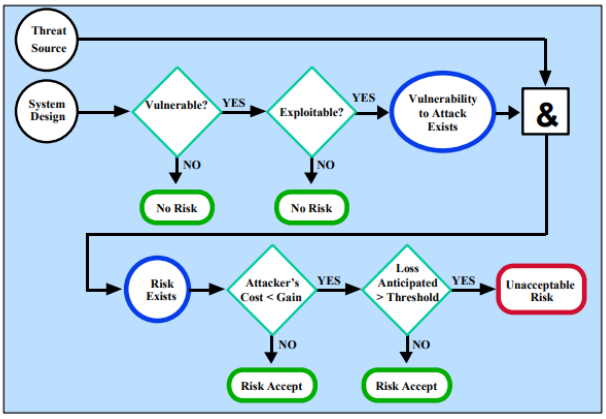

Figure 4: Risk Mitigation Action Points[12]

4. **Monitoring the risk:** This consists of monitoring the status of identified hazards and determining how well they are being managed. Collecting information and comments to evaluate the effectiveness of risk management strategies. modifying risk management plans as necessary in light of evolving conditions and making certain that fresh dangers are found and included in the risk management procedure.

5. **Reporting the risk:** Reporting is all about communicating and showing the results of the risk assessment output to stake holders. There are two kinds of report structures for reporting operational risks namely **disaster recovery test report** and **vulnerability assessment report**. Disaster recovery test report is used in business continuity management which is one of the recent risk management frameworks[6], and vulnerability assessment report is one of the reports that are used in risk assessment to lists all the vulnerabilities found in systems during a vulnerability scan. The report provides the list of vulnerabilities ranked by severity[14].

Torabi, Giahi and Sahebjamnia [6] developed a riak assessment framework that can assist business entrepreneurs to handle continuity management.
Djemame *et al.,* [11] conducted a study on risk assessment framework that can be used for cloud computing. They further described stages where risk assessment can be carried out in a project lifecycle and the risk models that cab be applied.

Albakri *et al.,* [17] study on security risk assessment framework for cloud computing environments enables cloud users to evaluate security risk factors associated with their system thereby avoiding a third paryy involvement in the risk assessment process. The authors did not develop any tool or techniques for business intelligence in their framework.
It is evident from the look at literature that there is a research gap on risk assessment using business intelligence framework ansd this has impaired organizations efforts at achieving success in risk mitigation and business failures.
Document automation is an integral part of BI as its prepares and convert all hardcopies and unstructured documents to soft form and making them available to the systems for use. According [19, 20], the following are the benefits of automating documents namely: Faster document generation, reduced error, better end-user experience, greater access, easy collaboration, more security and it saves time.
Mishra and Saini [21] conducted a study that explored business intelligence and analytics applications in Indian banks. They used focused studies such as interviews and case studies. They also found areas that needs to be improved when implementing BI in Indian banks although they did not proffer solution on how to integrate BI with risk assessment. Their study only concentrated only on business intelligence.
Chikohora and Esiefarienrhe [22] conducted a study that proposed a framework to guide and help small scale enterprises on the requirements for business intelligence system implementation. They identified some of the major risks that small-scale enterprises might encounter while they are implementing BI systems.

They predicted that in the future their framework will be improved to include ability to calculate the readiness of small-scale enterprises to implement BI.
Nadeem and Jaffri [23] conducted research on the application of business intelligence in banks in Pakistan. In their research they defined what BI is, how BI applications can be deployed and how to identify BI opportunities. The authors did not identify any risks or used any risk assessment methodology.

Comprehensive reviews on framework development
Chikohora and Esiefarienrhe [22] conducted a study that proposed a framework to guide and assist small scale enterpreneurs on the requirements for business intelligence system implementation. Their framework design steps shown in figure 5 consists of how to carry out, develop, or oversee a process.

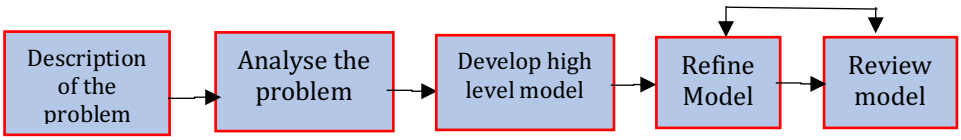

Figure 5. Framework design steps[22]

Authors in [24] conducted a study called "Framework Design: A Role Modeling Approach". They developed a role modeling for framework which makes designing, learning and using object oriented framework easier than traditional class-based approaches. They defined role modeling for frameworks as an evolutionary extension of class-based modeling for frameworks.

B. Research Method

The Systematic Literature Review (SLR) methodology was used in this research to identify effectively how to integrate risk assessment processes with business intelligence in organisations. To do this, SLR recommendations by Keele [25] were used. The SLR consists of an in-depth examination of papers related to risk assessment, business intelligence, risk assessment using business intelligence and framework design. The knowledge domain search was carried out using various databases such as Google Schoolar, IEEE Xplore, Science Direct and Research Gate. The search was carried out using a search string or query outlined as follows:.

1. Search String Formation

String creation was the initial step in the search process. The search string was created using key terms namely: 1) Risk assessment, 2) Business intelligence, 3) Framework design methodology/steps, 4) Risk assessment using business intelligence, 5) Intelligence software development.

- For the key terms, synonyms and alternate terms were identified for example, risk assessment (risk assessment process, risk assessment methodology, risk assessment framework, risk assessment steps, risk taxonomy, risk assessment report phase), BI (Document Automation,

Microsoft Power bi, Microsoft Power Apps, dashboards), framework design (Framework design methodology and framework design steps),

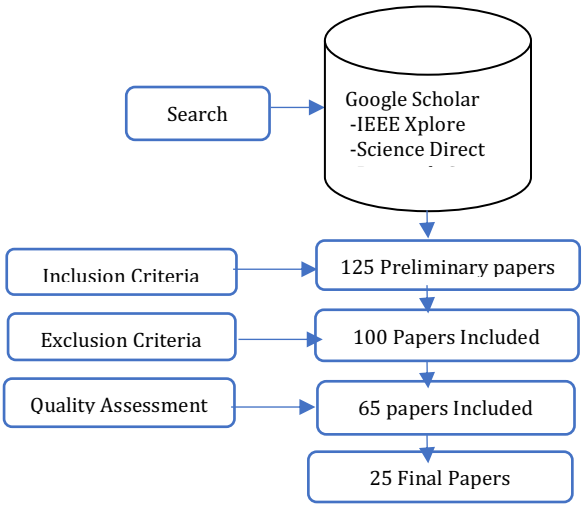

Figure 6. Quality Assessment Search Process

risk assessment using business intelligence framework (risk assessment process, risk assessment steps, risk assessment framework, risk assessment using business intelligence, Document Automation, dashboards, Microsoft power apps, Microsoft power bi, Framework design methodology/steps, risk assessment report phase).
Where necessary the authors used wildcards in search terms.
The authors utilized Boolean operators (OR, AND) where required, to concatenate search results. After the application of the search techniques the following final search strings were formulated: ("risk assessment methodology", "risk assessment process") AND "business intelligence software", "Automation" OR "Document automation", "Framework design methodology" OR "Framework design steps", "Microsoft power bi dashboards" AND "Microsoft power app" etc.

2. Paper Relevance Selection

The relevance paper selection approach, which is broken down into steps (see figure 6) was carried out to uncover papers that provide direct evidence based on their study titles. As shown in figure 9, a total of 125 papers were scooped from the various databases using key terms and after considering the inclusion criteria, 25 papers were eliminated leaving a total of 100 papers. Apart from the search key terms, the inclusion criteria also considered the language in which the article was written and publication date.
Then the exclusion criteria were applied, eliminating 35 papers leaving a total of 65 papers. Exclusion criteria applied entails eliminating papers that did not address any components of the research questions, research aims, or have nothing to do with relating business intelligence to software approach were disqualified.

The papers selected after applying both inclusive and exclusive criteria are shown in table 1.

Table 1: Inclusive/Exclusive criteria process selected sources.

Criteria	Selected Articles
Inclusive Criteria	[1] [4] [6] [7] [8] [9] [10] [13] [14] [15] [16] [18] [19] [20] [22] [24] [25]
Exclusive Criteria	[2] [3] [5] [11] [12] [17] [21] [23]

Finally, quality assurance criteria were applied to the remaining 65 papers culminating in the elimination of 40 papers leaving 25 papers that met all the required criteria to be used for the review. Quality criteria entails eliminating papers that did not meet a minimum standard of quality or did not follow strict research procedures, including those that used various equations/formulas without providing acceptable justification for their usage. The 25 used papers were from the following research databases namely 9 papers from Google scholar, 7 papers from IEEE Xplore, 5 papers from Science Direct and 4 papers from Research Gate.

3.Quality Assessment Process

Papers analysed were selected based on each study quality assessment conducted as follows: The two categories of "qualitative checklist studies" and "quantitative checklist studies" were applied to all included papers. The division significantly contributed to the identification of articles' biasness and mitigations, consistency, and comparability thus aiding the evaluate of their findings. A checklist questions as shown in table 2 for quantitative and table 3 for qualitative were posed and answers were to be provided that reflect the content, reasoning of the researchers and their findings. All articles were read and sorted out according to how they provided answers to the questions in the checklist.

Table 2: Quality Assessment Checklist

Questions	Experimental Quantitative Studies	Observational studies	Surveys	Source

Are the research questions and aim clearly stated	x		x	[1] [4] [6] [7] [8] [9] [10] [13]
Is the study design suitable for answering the research questions	x	x		[1] [4] [9] [13]
Is the sample size adequate to produce solid results?			x	[18] [19] [20] [22] [25]
Were appropriate statistical methods used to analyze the data?	x		x	[1] [4] [6, 19] [20] [22]
Have the right statistical techniques been used to analyse the data?	x	x		[4] [6] [7]
Do the conclusions support the findings and research question?	x	x		[18] [19] [20]
Were the study's limitations addressed?		x	x	[1] [4, 20] [22] [24] [25]

Table 3: Quality checklist for qualitative research

Questions	Source
Is the study's goal or question well-defined?	[1] [4] [6] [7] [8] [9] [10] [13] [14] [15] [20] [22]

Was the study's sample and subjects properly chosen?	[1] [4, 6] [7] [8] [9] [20] [22]
Is the study's methodology and design fully described?	[9] [10] [13] [21] [22]
Were the right methods of data collection used?	[1] [4] [6] [1] [4] [6]
Are the methods for data analysis exacting?	[1] [4, 18] [19] [20]
Are the research results presented clearly?	[1] [4] [6] [7] [8] [9] [1] [4] [6] [7] [8] [9] [1] [4] [6] [7] [8] [9]
Were there discussions about the findings	[18] [19] [20] [18] [19] [20]
Does the research offer proof of its reliability?	[20] [18] [19]
Are the conclusions generalizable or applicable to other contexts?	[18] [19]
Are the sources correctly and completely cited?	[1] [4] [6] [7] [8] [9] [10] [13] [14] [15] [16] [18] [19] [20] [22] [24] [25]
Does the study contribute to the existing literature?	[1] [4] [6] [7] [8] [9] [10] [16] [18] [19]

3.Data Extraction

Data from each selected paper was extracted from various databases based on article title, publication type (journal, conference, book chapter, thesis), conference/ journal/ book/thesis name, publication year, author's name, methodology applied in the paper, risk assessment using business intelligence. Figure 7 shows different databases used to get the papers. Most of the papers were taken from Google Schoolar and IEEE Xplore and the various papers' year of publications and the numbers of articles retrieved for each year starting from 2015 to 2023 are shown in figure 8. The type classification of the papers whether they are articles, conference papers, books or Journals is shown in figure 9.

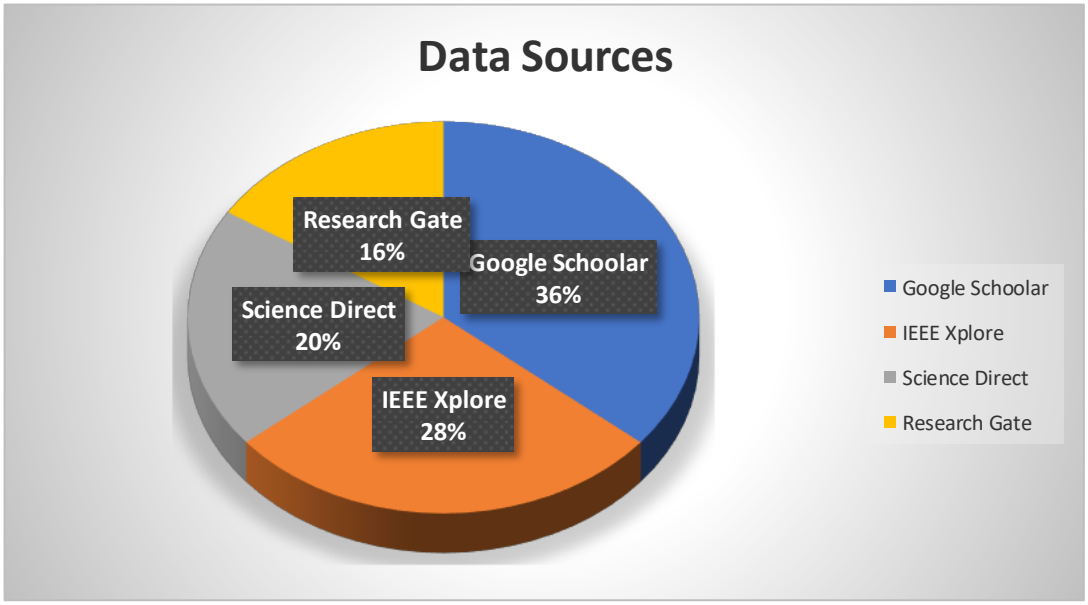

Figure 7. Percentage of papers pulled from various databases.

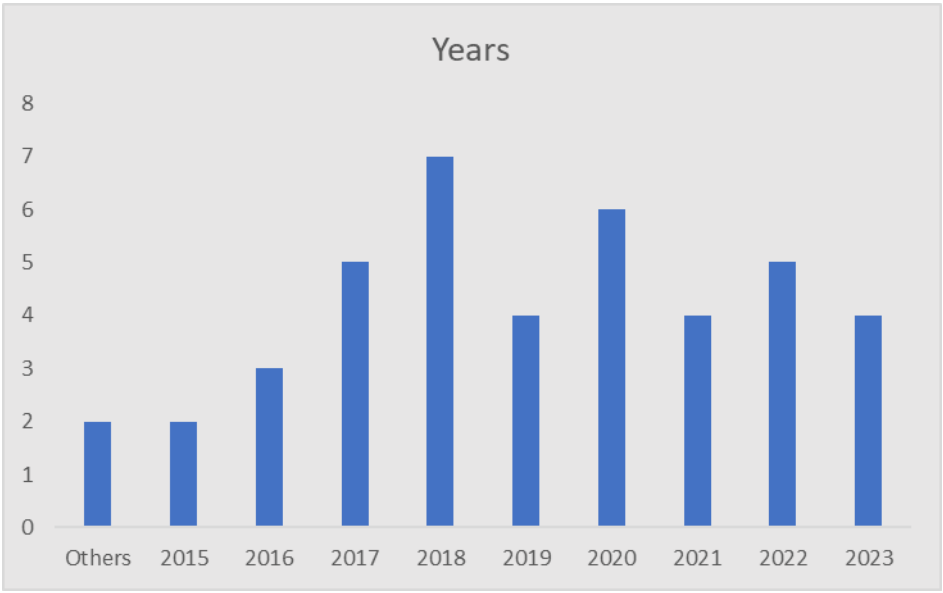

Figure 8. Publication years of study.

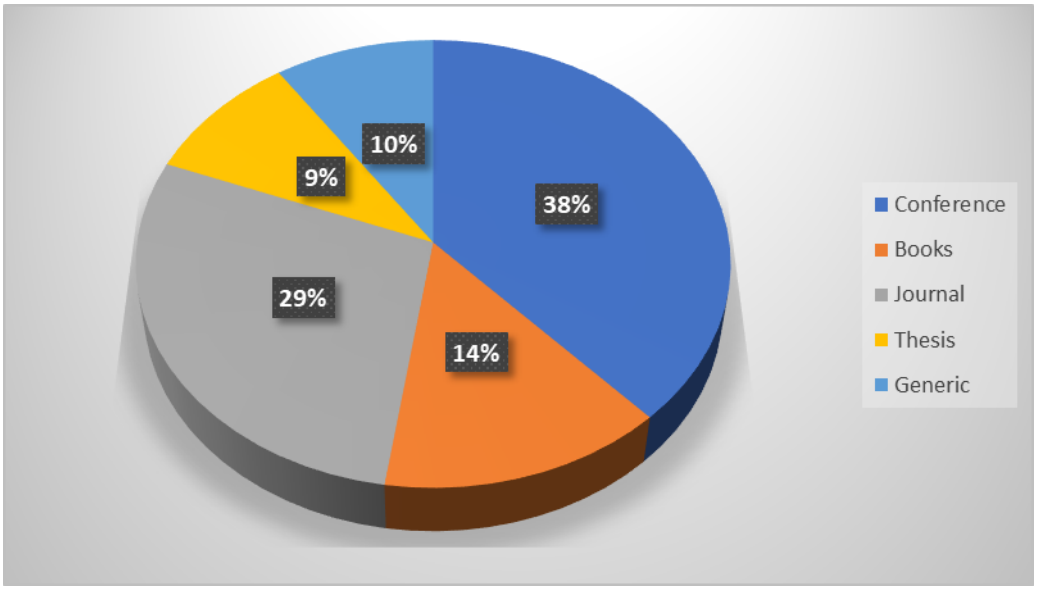

Figure 9: Publication type of studies

C. Results and Discussion

The papers referenced were categories into specific research focus area that they discussed and analysed in their research which were derived by studying their research aim, questions and objectives. The results in table 4 shows the results of these analyses as it classified in the first row the research area and a "Y" means the paper covered that research area in their work and a "N"implies they did not. Table 4 is important to future researchers as it assist them to identify research gaps in business intelligence systems and pave way for a novel research.

Table 4: Summary of papers analysis based on research aim, question and research objectives

papers	Risk assessment	Business intelligence	Framework design	Document automation/ intelligent software	Risk assessment process/met hodology	Analysis using Bi and Excel	Survey	Other tools
[1]	Y	N	N	N	Y	N	Y	N
[2]	Y	N	N	N	Y	N	N	N
[3]	Y	N	N	N	Y	N	Y	Y
[4]	Y	N	Y	N	Y	N	Y	Y
[5]	Y	N	Y	N	Y	N	N	Y
[6]	Y	N	Y	N	Y	N	N	Y
[7]	Y	N	N	N	Y	N	N	Y
[8]	Y	N	Y	N	Y	N	N	Y
[9]	Y	Y	N	N	Y	Y	N	Y
[10]	Y	Y	N	N	Y	Y	N	Y
[11]	Y	N	Y	N	Y	Y	Y	Y
[12]	Y	N	Y	N	Y	N	Y	N
[13]	Y	N	N	N	Y	N	Y	Y

[14]	Y	N	N	N	N	Y	N	Y
[15]	Y	N	N	N	N	N	N	N
[16]	N	Y	Y	N	Y	N	N	N
[17]	N	Y	Y	N	Y	N	N	Y
[18]	N	Y	Y	N	Y	N	N	Y
[19]	N	Y	Y	N	Y	N	Y	Y
[20]	N	Y	Y	N	Y	N	Y	Y
[21]	N	Y	Y	N	Y	N	Y	Y
[22]	N	Y	Y	N	N	N	Y	Y
[23]	N	Y	Y	N	N	N	N	Y
[24]	N	Y	Y	N	N	N	N	Y
[25]	N	Y	N	N	N	N	N	Y

.

1.Discussions on selected papers

The most important studies on which this review paper is focusing are those that are listed in tables 2 (quantitative studies) and 3 (qualitative studies). The majority of those papers follow the review's research aims and objectives. The majority of the chosen publications, as seen in figure 10, were collected from IEEE Xplore and Google Scholar because of their recent publication dates. While the newest publications were published in 2023, the oldest paper was published in 2000 (included for its significant material). The papers that were chosen were chosen based on the different methods they used for business intelligence-driven risk assessment. As can be seen in figure 12, the majority of their publications were journal and conference articles.

Table 5. Results of articles based on business intelligence and risk assessment analysis

No	Category	Research focus	Brief analysis of the studies
1.	Study coverage	Risk Assessment	Various authors as seen in table 4 dicussed risk assessment and the methodologies used in risk assessment, the steps involved in risk assessment, how to conduct risk assessment in different industries and also, they mentioned the reporting documents that are involved in risk assessment
		Business Intelligence	Studies as seen in table 4 discussed business intelligence and some of the authors developed framework on how to implement business intelligence systems. Some studies covered Document Automation and Microsoft power bi as the analysis tool and Microsoft power apps as the software development tool.
2.			Most researchers used primary and secondary sources of data in their research. Data collecting

	Design perspect ives	Gathering of data	techniques included reading other research works, the use of surveys and questionnaires. Other methods they used for collecting data include fieldwork, direct observation by researchers, case studies, interviews, and data gathering from already-existing web sources.
		software creation	Studies covered software tools that are web-based such Microsoft Power Apps and power bi. Few studies developed their own BIS using traditional software languages.
	Software testing	Quality Testing, Security Testing and Accuracy Testing	Most of the papers carried out functional and accuracy testing which invariably implies that they were mostly interested in their solution workability. Most of the functions were not tested individually (functional and unit testing) They lack quality testing and hence their software maybe not ensure compliance with data privacy and protection, vulnerability assessments and penetration assesment.
3.	Research analysis	Data visualizations	Most of the authors used MS-Excel, Power bi for data a visualization.
		Data Filtration	Papers used a variety of methods, including time-based filtrations, which involved choosing data from a specific time period relevant to their studies, data focusing on a particular project phase or location, removing anomalies or outliers from the datasets, and concentrating on recently generated data, to make sure that the data used is in line with research objectives.
		Data synthesize	Studies gathered information from a variety of sources, including the Try-Hack-Me platform and other relevant databases. Data were then transformed and cleaned up by deleting duplicates. As a result, many techniques were used, including data aggregation, correlation, and causality analysis, and risk assessment using business intelligence optimization. and identifying risk assessment using business intelligence optimization opportunities
4.	significa nce and implicati ons of the findings	Study importance reflections	Most of the studies addressed important issues that organizations encountered while assessing risk by utilizing business intelligence to accomplish their goals, supporting data-driven decision-making.

		Contribution to existing knowledge	Most of the research offered empirical proof that business intelligence is beneficial in the risk assessment process.

D. Conclusion and future research

Several libraries and databases were consulted including Google Scholar, IEEE Xplore, Science Direct, and Research Gate to extract papers used in this review. Most of the articles chosen from these databases are journal and conference papers, and their publication dates typically fall between 2000 and 2023. Both inclusive, exclusive and quality criteria were used to select papers reviewed to ensure that provide insightful information on risk assessment and data-driven decision-making. The findings of these studies highlight the value of BI-driven frameworks in converting raw data into useful insights for risk assessment processes. BI has become a powerful instrument for companies use to promote improvements in risk assessment by utilizing predictive analytics and data visualization.

In future, researchers and specialists must create additional business intelligence tools that can visualize data from multiple sources. Future studies can explore the use of AI, machine learning and deep learning approaches to control their risk assessment process. Develop novel technologies can give BI tools access to more complex analytics and decision-making tools.

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