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Master Thesis

Improving the Job Search Experience with Multi-Criteria Decision Making (MCDM) Visualization

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Abstract

Purpose and Research Question: This research aimed to develop and evaluate the usability of a novel job search visualization tool using a combination of a specific Multi-Criteria Decision Making (MCDM) tool and Attribute Scoring Functions (referred to as Qualitative Criteria Quantifier in this study) visualization. The central question addressed was: "How can the application of MCDM principles and advanced visualization techniques improve the efficacy and user experience in online job search processes?" This study aimed to enhance the job-seeking experience by offering a more intuitive and efficient approach to navigating the job market.

Methodology: The study employed a mixed-methods approach, focusing on the development and evaluation of the visualization tool. The development phase involved integrating the Qualitative Criteria Quantifier into LineUp, while the evaluation phase consisted of a user study with university students and young professionals. Data were collected through usability tests and interviews.

Key Findings: The user study revealed that usage of the Qualitative Criteria Quantifier increased participants' reported confidence in their decisions compared to decisions made using only the MCDM tool. Furthermore, participants indicated that the visualization aspect helped them better understand job preferences and options.

Conclusion: The research suggests that combining Qualitative Criteria Quantifier with MCDM visualization enhances user experiences in the job-seeking domain. The objectives of developing a more efficient and informative tool were successfully met, demonstrating the potential applicability of MCDM in job search interfaces. These findings open new avenues for further exploration in digital interface design, emphasizing user-centric approaches in technology development.

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Introduction

In recent years, the job-seeking process has undergone significant changes due to the rise of digital platforms (12). According to the 2015 Pew Report (13), over 79% of job seekers now use online platforms, including job boards, social media, and professional networking sites, to find employment opportunities. These platforms offer a vast array of opportunities but also introduce unique challenges.

As job seekers navigate the increasingly complex digital landscape, they face challenges in processing the vast amounts of information available, comparing alternative job opportunities, and making informed decisions that align with their career goals and personal preferences. On average, a job seeker submits between 21 to 80 applications to secure a single job offer (14). The overwhelming volume of data can create barriers to identifying and evaluating the most suitable job options, ultimately impacting their job-seeking experience.

Wanberg et. al identified several research questions in the domain of job-seeking that are relevant to identifying tools to support job-seeking behavior (15).

- *"What job search behaviors do job seekers engage in online and what are their outcomes? What factors could improve online job search for job seekers?"*
- *"How and to what extent does a job search quality make a difference in achieving job search success?"*

Job search quality is defined by Van Hooft et al. as *"the extent to which a job search is self-regulated, that is, the extent to which a job search is conducted by cycling through the four sequential self-regulatory phases of goal establishment, planning of the goal pursuit, goal striving, and reflection"* (16).

While the intricacies of job search behaviors and their outcomes are being explored, there is a growing recognition of the potential role of technology in enhancing the job search process. Just as visualization tools like FinVis in finance (17), SOVAT in healthcare (18), and CityZoom (19) in urban planning have improved decision-making in their respective domains, similar tools could be pivotal in the realm of job searching.

Visualization tools, by presenting complex data in a comprehensible way, can aid job seekers in identifying personal preferences, comparing options, and making informed decisions about their career paths. By helping job seekers direct their searching efforts in an efficient and effective way, these tools can enable them to make more informed decisions, increase their chances of finding the right job, and ultimately enhance their overall job-seeking experience. However, despite their potential benefits, existing visualization tools for job seekers may not fully address the unique challenges and needs of this user group, leaving room for improvement and innovation.

While visualization tools have demonstrated value in various decision-making contexts (20), current tools for job seekers may not fully address their unique challenges and needs. For instance, existing tools may lack personalized features, fail to capture nuanced job criteria, or inadequately present complex job-related data, limiting their effectiveness in facilitating job seekers' decision-making processes. Visualizations can be a valuable tool in addressing this issue, as they can help organize and present information in a more digestible manner.

Given the importance of making well-informed decisions during the job search process, there is a need for a deeper understanding of how visualization tools can be designed and improved to better support job seekers' decision-making experience. The problem this research aims to address is the identification of gaps and limitations in existing job-seeking-focused visualization tools and the exploration of ways to enhance their effectiveness in facilitating job seekers' decision-making processes. The primary goal of this research is to improve job-seeking quality through visualization tools for job search-related data.

The objectives of this research are:

1. To explore and understand the unique visualization needs and preferences of job seekers during their job search process.

2. To identify the limitations and gaps in existing visualization tools as they pertain to job-seeking.

3. To propose a novel visualization prototype tailored to the specific needs of job seekers.

4. To evaluate the effectiveness of the proposed prototype in enhancing job seekers' decision-making and overall experience during a job search.

To achieve the research objectives, this study aims to address the following research questions:

1. What are the limitations and gaps in existing visualization tools in the context of job-seeking and decision-making?
2. What are the unique visualization needs and preferences of job seekers as they search for and evaluate job opportunities?
3. How can a novel visualization tool be designed to better address the unique needs of job seekers and support their decision-making process?
4. Does the proposed visualization prototype effectively enhance job seekers' decision-making experience and overall satisfaction during the job search process?

2

Background

2.1 Job Seeking

The job seeking process has evolved significantly, influenced multiple factors ranging from individual behaviors to technological advancements. This section delves into the contemporary methodologies and strategies inherent in the job seeking process, as informed by recent academic research.

At the core of job seeking are the individual strategies and behaviors of job seekers. Research indicates that a deep understanding of these personal dynamics is vital for an effective job search experience. Different approaches adopted by individuals highlight the need for a nuanced understanding of these tactics to enhance job search outcomes (21).

An important element in job seeking is the learning curve experienced by job seekers. It is a dynamic process where individuals continuously refine their strategies based on past experiences and feedback. This adaptive approach underscores the significance of learning and evolution in the job search process (22).

Another key aspect is the role of self-regulation in achieving job search success. Studies suggest that job seekers who effectively manage their emotions, motivations, and behaviors are more likely to succeed. This highlights the importance of self-regulatory practices in navigating the complexities of the job search landscape (23).

The digital transformation of the 21st century has fundamentally altered the job seeking process. The rise of digital platforms, including the internet and social media, has reshaped traditional job search methods, presenting both new opportunities and challenges. This evolution fundamentally changes the way job seekers connect with potential employers (24).

Lastly, the integration of technology in job seeking is a significant development. The use of various digital tools and platforms has become increasingly important, bridging the gap between job seekers and employers. This technological integration streamlines the recruitment process, enhancing the efficiency and effectiveness of job seeking (25).

2.1.1 Influences on Decision-Making in Job Searching

In the realm of job seeking, decision-making is influenced by a blend of individual preferences, the impact of abundant information, and technological advancements. This section explores these dynamics and their implications for job seekers.

The selection process in job seeking is a complex and highly individualized endeavor. Smith's research (26) highlights that this process goes beyond the mere matching of skills and qualifications. It involves evaluating various factors such as company culture, career progression opportunities, compensation, and work-life balance. Job seekers weigh these aspects based on personal values and career goals, making the process a nuanced balance between rational analysis and individual preferences.

Liu et al. (27) categorize job seekers into two distinct decision-making styles: maximizers and satisficers. Maximizers endeavor to find the optimal job, engaging in an extensive search to ensure the best possible outcome. Satisficers, conversely, seek jobs that sufficiently meet their criteria, focusing on finding positions that are "good enough" rather than optimal. This dichotomy in decision-making styles is pivotal in understanding the varied approaches individuals take during their job search. It elucidates how personal decision-making frameworks can shape the trajectory of job seeking, from initial information gathering to the final acceptance of a job offer.

The study also highlights the significance of various information sources in the job search process. Job seekers utilize a blend of formal (such as job advertisements) and informal (such as word-of-mouth recommendations) channels to gather information (27). This phase of information gathering is crucial as it influences the job seekers' perception of potential employers and the attractiveness of the job market. The diversity of these sources underscores the multifaceted nature of job seeking, where individuals synthesize information from multiple channels to form their understanding of the available opportunities.

Halaby's study (28) points out that the abundance of information available to job seekers significantly influences their decision-making process. While this information allows for an in-depth evaluation of opportunities, it also poses the challenge of information overload. Job seekers must therefore develop competencies in filtering and interpreting this information to make informed and strategic decisions.

Advancements in technology, particularly in smart job seeking systems, also influence decision-making in the job seeking process. Alksasbeh et al.'s work (29) illustrates how these systems utilize advanced information retrieval techniques to tailor the job search experience. These technologies aid in efficiently matching job seekers with suitable opportunities, adapting to their unique preferences and qualifications. The use of these technologies addresses the subjectivity in job preferences and requirements, enhancing the relevance of job matches.

The decision-making process in job seeking is a multifaceted and dynamic interaction of personal preferences, information management, and technology. Understanding these elements is essential for job seekers in navigating the complexities of the job market and for developers in creating effective job seeking tools.

2.2 Decision Making

Building upon the previously discussed features of decision making in job seeking, this section aims to bridge these features with existing decision making theories and frameworks, particularly Herbert A. Simon's three-stage model of Intelligence, Design, and Choice (30). By applying this model, we will explore the nuances and complexities specific to the decision making process in job seeking.

2.2.1 Intelligence Stage in Job Seeking

In the Intelligence stage, job seekers engage in a process akin to environmental scanning, as described by Simon. This involves gathering information about job markets, potential roles, and industry trends. For instance, a job seeker might analyze the demand for their skills in different sectors or the growth prospects of various industries, reflecting Simon's concept of identifying problems or opportunities.

2.2.2 Design Stage in the Context of Job Seeking

The Design stage in job seeking involves developing a strategy for the job search. Here, job seekers brainstorm potential career paths, create resumes tailored to specific roles, and evaluate the pros and cons of different job types or industries. This stage mirrors Simon's idea of generating and evaluating various alternatives, highlighting the strategic aspect of job seeking.

2.2.3 Choice Stage and its Complexities

The Choice stage, as per Simon's model, is where the final decision is made. In job seeking, this translates to selecting a job offer or a career path. However, as Keeney (31) highlights, this stage is often fraught with complexities due to multiple conflicting objectives, such as balancing salary expectations with work-life balance or company culture with career advancement opportunities. This complexity indicates that job seeking decisions often involve reconciling these conflicting criteria, making this stage particularly challenging.

In conclusion, Simon's three-stage model offers valuable insights into the decision making process of job searching. Additionally, its application highlights the need for further considerations, particularly the emotional and non-linear aspects of such decisions. This complexity makes the Choice stage of Simon's decision making model particularly challenging and complex which allows us to consider this decision as ill-defined.

2.2.4 Job Seeking as Ill-Defined Decision Making

Job seeking can be considered ill-defined decision-making, as it is characterized by a lack of clear structure and objective criteria. Unlike problems with defined goals, job seeking involves subjective and diverse objectives that vary from one individual to another, such as career progression, work-life balance, or organizational culture. These varying goals, coupled with the subjective nature of job satisfaction and the dynamic job market, add layers of complexity to the decision making process.

Key features of ill-defined decision-making problems as characterized by Ackoff (32) include:

- **Ambiguity**: The objectives, criteria, and potential solutions are often unclear, making it challenging to establish a definitive course of action (33).
- **Vagueness**: Unlike well-defined problems, ill-defined problems have vague boundaries, complicating the evaluation of potential solutions (34).
- **Multiple Perspectives**: These problems often involve various stakeholders, each with unique perspectives, preferences, and values (32).
- **Dynamic Nature**: Ill-defined problems are not static and evolve over time, requiring an adaptive decision-making approach (35).

For instance, a job seeker may encounter vague or contradictory job descriptions, making it difficult to evaluate the opportunity based on established criteria. Additionally, the dynamic nature of the job market introduces new variables and constraints that can change over time, further complicating the decision-making process (35).

To address these complexities, various decision making frameworks have been developed, one of which is Multi-Criteria Decision Making (MCDM). MCDM offers a structured approach to evaluate multiple conflicting criteria in decision-making scenarios (36). While the Choice stage in Simon's model provides a foundation, MCDM offers advanced tools for making more nuanced decisions.

2.3 Multi-Criteria Decision Making (MCDM)

Multi-criteria decision-making (MCDM) offers a structured framework that significantly enhances the decision-making experience, particularly in complex scenarios common in job searching. When job seekers are faced with multiple job opportunities, each presenting a unique set of criteria and trade-offs, the decision making process can become overwhelmingly intricate. MCDM aids in systematically weighing the relative importance of these various criteria, allowing individuals to navigate through the complexity with greater clarity and confidence.

2.3.1 Introduction to Multi-Criteria Decision Making (MCDM)

Multi-Criteria Decision Making (MCDM) is a well-established branch of decision science that encompasses a diverse array of methods, techniques, and approaches designed to facilitate the evaluation and selection of alternatives based on multiple, often conflicting, criteria (37). MCDM allows decision makers to systematically analyze complex decision-making problems by considering the trade-offs between multiple objectives and finding an optimal or satisfactory solution.

In various real-world contexts, decision making scenarios are frequently characterized by the presence of multiple criteria that must be simultaneously taken into account. These scenarios can range from business investment decisions (38), environmental management (39) to urban planning (40). MCDM provides a structured framework to assist decision-makers in navigating the intricate landscape of such problems, enabling them to prioritize their objectives and make informed, defensible choices (37).

In the context of job seeking, individuals are confronted with the challenging task of evaluating and selecting from a multitude of employment opportunities, each presenting

its own unique combination of attributes. These attributes, or decision criteria, may include factors such as salary, job satisfaction, location, work-life balance, and company culture, among others (15). Given the highly personal and subjective nature of these criteria, job seekers often face considerable difficulty in making well-informed decisions that adequately address their preferences and priorities (15).

Thus, the application of MCDM to the job search process has the potential to significantly enhance the decision-making experience by enabling job seekers to systematically weigh the relative importance of various criteria and assess the trade-offs between different job opportunities. By incorporating MCDM methods into the job search process, individuals can gain greater clarity and confidence in their decision-making, ultimately leading to more satisfactory and fulfilling career choices (41).

In light of the diverse and often conflicting factors involved in job searching, such as job location, salary, and company culture, the role of Multi-Criteria Decision Making (MCDM) methods becomes crucial. While the complexity of the job search and the utility of MCDM in navigating this complexity has been acknowledged, it is beneficial to explore the specific applications of MCDM in this context.

For instance, MCDM methods can be instrumental in systematically breaking down the job search criteria. By applying techniques like Analytic Hierarchy Process (AHP) or Technique for Order Preference by Similarity to Ideal Solution (TOPSIS), job seekers can quantify and prioritize their preferences, leading to more targeted and efficient job searches. Such methods have been successfully applied in various domains, as evidenced by Ishizaka and Nemery (42), and their application in job searching can similarly facilitate a more structured and informed decision-making process.

Furthermore, MCDM's role in the comparative analysis of job offers is significant. As outlined by Pohekar and Ramachandran (43), MCDM methodologies allow for a comprehensive evaluation of job offers, considering various dimensions such as career advancement, work-life balance, and compensation packages. This holistic approach aids job seekers in making choices that align more closely with their career goals and personal values.

Thus, the application of MCDM in job seeking extends beyond just acknowledging its potential; it involves practical implementation that can significantly enhance the decision-making process for job seekers, as supported by the work of Greco et al. (44).

2.3.2 MCDM Methods in the job seeking domain

MCDM encompasses a diverse set of methodologies, each offering unique perspectives in evaluating job opportunities. This section focuses on specific MCDM methods and their

application in the job-seeking process, demonstrating their role in aiding candidates to navigate through the multifaceted job market.

AHP The Analytic Hierarchy Process (AHP), developed by Saaty (45), structures decision problems into a hierarchy. In job searching, this means breaking down the decision into main goals, criteria, sub-criteria, and alternatives. For instance, when considering job offers, a job seeker would use AHP to assess them against criteria like salary, location, and company culture, each potentially having its sub-criteria. Despite its structured approach, the subjective nature of AHP means the final decision still relies heavily on the job seeker's personal judgments and preferences (46).

Fuzzy method Fuzzy logic, as introduced by Zadeh (47), offers a way to handle imprecise or uncertain information in decision-making. For job seekers, this method is particularly useful in evaluating subjective criteria like work-life balance, where each job offer can be given a membership value indicating its alignment with the seeker's preference. This approach allows for a more nuanced decision-making process, especially in assessing criteria that are not easily quantifiable.

TOPSIS Technique for Order Preference by Similarity to Ideal Solution (TOPSIS), proposed by Hwang and Yoon (48), provides a method for selecting the most preferable alternative based on its closeness to the ideal solution. In job searching, TOPSIS could help candidates identify the job offer that best aligns with their ideal criteria, such as optimal salary, location, and company culture, and simultaneously distance it from the least desirable options.

VIKOR The VIseKriterijumska Optimizacija I Kompromisno Resenje (VIKOR) method focuses on identifying compromise solutions in multi-criteria decision contexts (49). In job-seeking, VIKOR can be instrumental in balancing the pros and cons of different job offers, helping candidates make choices that are not just optimal but also realistic and well-rounded.

The utilization of these MCDM methods transforms the intricate job search process into a more structured and manageable endeavor. By dissecting complex decisions into simpler, more quantifiable components, MCDM provides job seekers with a clearer path to making informed and optimal career choices. The subsequent section will explore how

MCDM software tools bring these theoretical methods into practical use, providing tangible support for job seekers.

2.3.3 MCDM Software in Job Seeking context

Multi-criteria decision-making (MCDM) software has emerged as a powerful tool in various domains, assisting in the systematic evaluation of options based on multiple criteria (50, 51). Its application in the context of job seeking, however, presents unique challenges, especially when addressing ill-defined problems.

MCDM tools are designed to facilitate complex decision-making processes by providing a structured framework to evaluate and rank multiple alternatives based on diverse criteria (42). These tools typically offer features such as criteria weighting, alternative ranking, sensitivity analysis, and graphical representations of results. They cater to both individuals and organizations, enabling them to navigate decisions that encompass various factors, from tangible ones like cost and efficiency to more subjective ones like satisfaction and preference.

In the realm of job seeking, MCDM software can be invaluable. Job seekers can utilize these tools to assess various job opportunities based on multiple dimensions, including salary, location, work-life balance, and company culture (36). The structured approach provided by MCDM software ensures that job seekers consider all relevant factors, leading to more informed and holistic decisions.

2.3.3.1 Application of Visualization in MCDM

Visualization, a crucial component within MCDM tools, differs significantly from the software itself. While software encompasses the programs and operating information for data analysis and decision-making, visualization focuses on presenting data in a graphical format, enhancing understanding and usability (52).

Tamara Munzner, a leading expert in the field of visualization, argues that visualization systems can augment the capabilities of MCDM tools in handling ill-defined problems (53). According to Munzner:

> "Many analysis problems are ill-specified... In such cases, the best path forward is an analysis process with a human in the loop... Vis systems are appropriate for use when your goal is to augment human capabilities, rather than completely replace the human in the loop."

Building on Munzner's insights, visualization techniques can serve as a powerful adjunct to traditional MCDM tools. They can help in representing complex, ambiguous data in a more intuitive manner, thereby aiding the decision-making process. For example, visualization can make it easier to compare multiple job opportunities based on various criteria. This becomes particularly important in the context of ill-defined problems, where traditional MCDM tools may fall short.

This argument sets the stage for the next section, which will delve into how visualization tools can enhance the effectiveness of MCDM software, particularly in the context of job seeking where personal preferences and priorities are crucial.

2.3.4 Visualization Tools role in decision making

Data visualization plays a crucial role in various tasks, including data analysis, sense-making, and decision-making, each of which involves distinct yet interconnected processes (54).

Data Analysis In data analysis, visualization supports the exploration, interpretation, and communication of complex data, making it easier to identify patterns, trends, relationships, and anomalies (55). For job seekers, this means being able to quickly discern which job listings align with their qualifications, experience, and interests. By visualizing data such as company reviews, salary trends, or job market statistics, job seekers can derive insights that guide their application strategy, ensuring they target positions that best match their profile and aspirations (56).

Sensmaking Sensemaking refers to the process of constructing meaningful narratives and understanding complex or uncertain situations (57). In the realm of job-seeking, this often involves piecing together information from various sources to form a coherent picture of potential employers, job roles, and career trajectories. Visualization assists in this sensemaking process by allowing job seekers to organize, filter, and manipulate data, such as company growth charts or employee satisfaction ratings. This enables them to build a coherent mental model of potential career paths and the broader job market landscape (58). Visualizations, therefore, serve as a cognitive tool that supports job seekers in developing a shared understanding of the job market, facilitating more informed choices (59).

Decision-Making Data visualization tools and techniques play an essential role in the decision-making process by presenting complex datasets in a comprehensible and accessible manner (60). Through the use of specific visual representations such as bar charts, line graphs, and heat maps, these tools enable users to identify patterns, trends, and correlations within the data that may otherwise remain concealed (56). Interaction means such as zooming, panning, and filtering further enhance the interpretative capabilities of the user, allowing them to focus on specific aspects of the data and conduct more in-depth analysis (61). In the context of job searching, these visual tools can be invaluable. For instance, a heat map might reveal job demand in various regions, guiding relocation decisions, while a line graph could illustrate the growth trajectory of a particular industry or company, informing career direction choices.

In the context of decision-making, visualization tools, and techniques offer a range of benefits, including reducing cognitive load, simplifying comparisons, and enhancing the exploration of trade-offs between different alternatives (62). For job seekers, this is particularly pertinent. Choosing a job involves weighing multiple factors, from salary and location to company culture and growth opportunities. By providing a clear visual representation of these factors, visualization aids job seekers in understanding the nuances of each job offer, allowing them to evaluate the long-term consequences of their choices (63).

In conclusion, data visualization plays a pivotal role across various tasks, such as data analysis, sensemaking, and decision-making, by transforming complex information into accessible visual representations. For job seekers, this means a more comprehensive understanding of the job market, clearer insights into potential career paths, and ultimately, more informed decisions. Visualization tools and techniques, therefore, hold significant potential to enhance the job search experience, addressing the multifaceted challenges faced by job seekers in today's dynamic job market.

3

Related Work

The landscape of data visualization tools has seen significant advancements in recent years, with multiple options now available to cater to various domain-specific and general-purpose needs. These tools play a critical role in facilitating data-driven decision-making processes across multiple sectors, including healthcare, finance, urban planning, and more. However, the realm of job seeking presents a unique set of challenges and requirements that are not fully addressed by existing visualization tools. This chapter aims to bridge this gap by conducting a comprehensive review of both domain-specific and general-purpose visualization tools, evaluating their applicability and adaptability in the context of job seeking.

The chapter begins by outlining the methodological approach adopted for the selection and analysis of relevant papers, drawing inspiration from the exhaustive review conducted by Emre Oral et al(64) Subsequently, the chapter delves into a systematic literature review, categorizing the tools into two primary categories: domain-specific and general-purpose. Each category is evaluated based on a set of criteria adapted from Tamara Munzner's Nested Model for Visualization Design and Validation. The objective is to assess the extent to which these tools can be customized or extended to meet the unique challenges and data types encountered in the job-seeking process.

By the end of this chapter, readers will gain a nuanced understanding of the current state of visualization tools and their potential applicability to job seeking.

3.1 Method

This section gives an overview of the paper selection process and the analysis.

3.1.1 Selection of Papers

In this study, the primary focus is on exploring decision-making tools in the context of visualization, with Emre Oral and colleagues' research serving as a key reference point. Oral et al. reviewed scholarly articles from leading journals and conferences, employing a targeted search strategy centered on decision-related keywords (64). This comprehensive search resulted in the identification of 27 papers that explicitly concentrate on the design of visualization tools intended to assist in decision-making processes.

For this study, these 27 papers were selected due to their direct relevance to decision-focused tools, thereby offering a substantial and pertinent foundation for analysis. Additionally, this study expands beyond the scope of Oral et al.'s selection by including supplementary tools such as LineUp (5) and Entscheidungsnavi (3). The rationale for incorporating tools lies in their contribution to decision support through effective visualization and guidance, despite their exclusion from the original dataset of 27 papers. This expanded selection approach aims to provide a more holistic and inclusive analysis of the role of visualization tools in decision-making.

3.1.2 Analysis

This section will analyze various visualization tools, evaluating them based on the Nested Model's criteria (1) as illustrated on Figure 3.1. The tools will be evaluated specifically based on job-seeking data and tasks such as comparing different job opportunities.

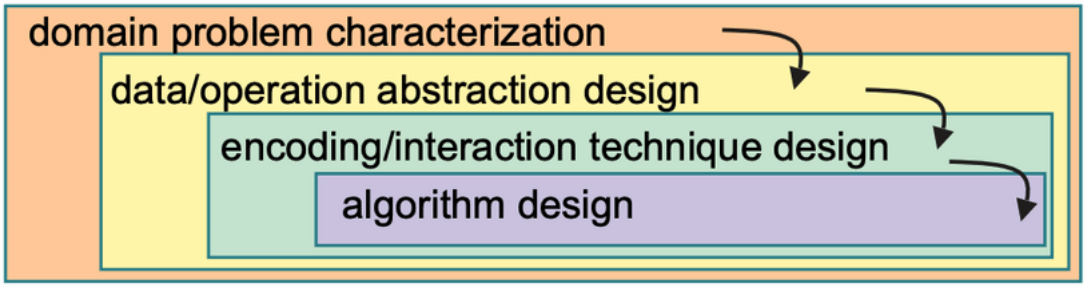

Figure 3.1: Tamara Munzner's Nested Model (1).

Tamara Munzner's Nested Model for Visualization Design and Validation provides a structured framework for evaluating visualization tools. When applied to the context of job seeking, each level of the model takes on specific relevance as outlined below.

Domain Situation in Job Seeking

In the realm of job seeking, the domain situation focuses on the specific needs and tasks of job seekers. The target audience here is individuals looking for employment opportunities. The primary tasks could include identifying suitable job openings, comparing salaries across different roles or companies, and understanding different criteria and how the influence the appeal of the job. The data available might consist of job listings, salary statistics, company reviews, and industry reports.

Data and Operation Types for Job Seekers

At this level, the focus shifts to the types of data that are most relevant to job seekers and the operations they would typically perform on this data. For instance, the data could be categorical (e.g., industry types, job roles) or numerical (e.g., salaries, company ratings). Operations could include sorting job listings by date, filtering them by location or industry, and aggregating salary data to find averages or ranges.

Encoding and Interaction Idioms in Job Seeking Tools

This level would explore how job-related data is visually represented in the tool and how users can interact with these visual elements. For example, job listings could be displayed on a map to show geographic distribution, and different colors could represent various industries. Interaction idioms might include the ability to zoom into specific regions on the map, click on job listings for more details, or use sliders to filter jobs by salary range.

Algorithms for Job Seeking Visualization Tools

Finally, this level would examine the technical aspects of the visualization tool, particularly its efficiency and scalability. Given that job seekers may need to sift through thousands of job listings or analyze large sets of salary data, the tool's algorithms must be optimized for performance. This could involve using efficient data structures for quick search and filter operations or employing caching mechanisms to improve load times.

By applying Tamara Munzner's Nested Model in this manner, one can systematically evaluate visualization tools designed for job seeking. This ensures that the tools are not only technically robust but also tailored to meet the specific needs and tasks of job seekers. By the end of this section, readers will have a nuanced understanding of the visualization tools available for data-driven decision-making in the job-seeking process. They will be

equipped to make informed choices that align with their job search objectives and constraints, all while adhering to the rigorous evaluative standards set by Tamara Munzner's Nested Model.

3.2 Systematic Literature Review

In order to provide a comprehensive understanding of the current state of research and to identify gaps in the existing body of knowledge, this chapter presents a systematic literature review, meticulously examining key studies, methodologies, and findings in the relevant domain.

3.2.1 Domain: A Comparative Analysis of Visualization Tools

This section aims to categorize and critically evaluate a selection of these visualization tools based on their applicability to the domain of job seeking. The analysis is classified into two primary categories: domain-specific tools and general-purpose tools.

The first category, domain-specific tools, focuses on visualization solutions that are engineered to address challenges and requirements unique to specific fields or sectors. These tools offer specialized functionalities but may not be directly applicable to the multifaceted needs of job-seeking.

The second category, general-purpose tools, explores visualization solutions that are not confined to a particular domain. These tools offer a broader range of functionalities and present the potential for adaptation to various contexts, including job seeking.

The objective of this section is to assess the extent to which these tools, both domain-specific and general-purpose, can be adapted or extended to meet the unique challenges and data types encountered in the job-seeking process. This analysis will provide insights into the versatility and limitations of these tools, thereby informing future research and development in the field of job-seeking visualization tools.

3.2.1.1 Domain-Specific Tools

A significant portion of the papers under review focus on visualization tools that are tailored to address specific domain challenges. For instance, *LiteVis* (Figure 3.2) is engineered for lighting design applications (2), while *ReACH* serves as a specialized tool for house hunting (65). Similarly, *ManyPlans* is designed to offer solutions for flood management (66),

and *BNVA* aims to optimize bus routes (67). In the financial sector, *FinVis* provides targeted insights for financial planning (68). Urban development is the focus of *Urbane* (69), whereas *FairSight* is developed to ensure fairness in decision-making processes (70).

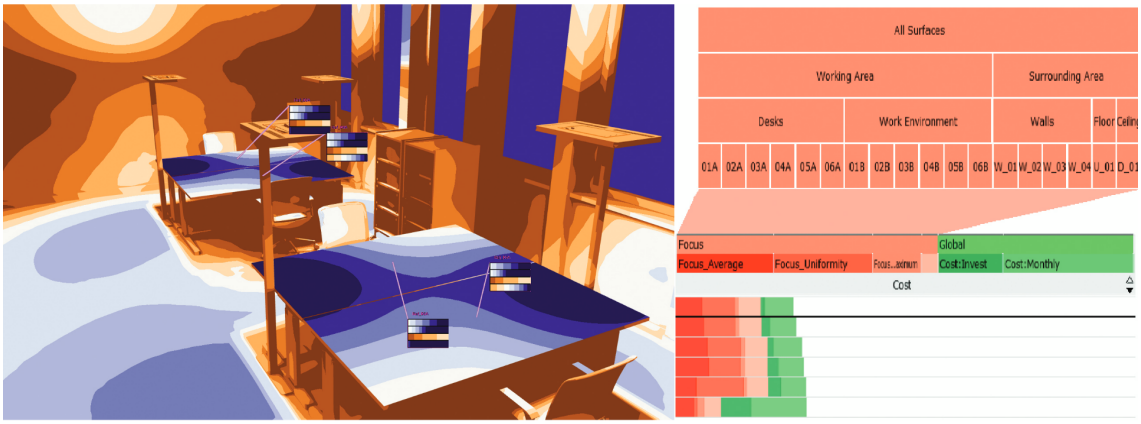

Figure 3.2: LiteVis interface (2).

In the healthcare sector, tools like *Pelt et al.* (71) and *Müller et al.* (72) offer comparative blood flow visualization for cerebral aneurysm treatment and visual assistance in clinical decision support, respectively. Interestingly, some tools like *SkyLens* (73), *SmartClient* (74), and *Stratos* (75) are domain-specific but cater to broader sectors. *SkyLens* is designed for visual analysis of skyline on multi-dimensional data, *SmartClient* aims to enrich buyers' experiences in e-commerce, and *Stratos* focuses on software release processes. These tools exemplify the diversity and specialization inherent in domain-specific visualization tools, each designed to meet unique challenges and requirements within their respective fields.

While these tools offer specialized solutions for their respective domains, they are not designed to handle the specific tasks and data types commonly encountered in job seeking. Their focus on domain-specific challenges, such as lighting design or financial planning, makes them less suitable for addressing the multi-faceted needs of job seekers, who require tools capable of aggregating and visualizing diverse types of data like job listings and salary statistics. Therefore, although these tools exemplify the depth and specialization inherent in domain-specific visualization, they do not align closely with the requirements of job-seeking tasks and data.

3.2.1.2 General Purpose Tools and Their Potential Applicability to Job Seeking

Multiple general-purpose tools exist which can be applied to multiple domains, including job-seeking.

Entscheidungsnavi offers a systematic, step-by-step process for identifying objectives, developing consequences tables (Figure 3.3), and evaluating alternatives (3). This structured approach is complemented by visual representations, facilitating easier comprehension and comparison of complex information. Unique to Entscheidungsnavi is its focus on structuring the decision-making process and its customizable nature, which contribute to its potential utility in the job-seeking context. The step-by-step process offers the user clear guidance.

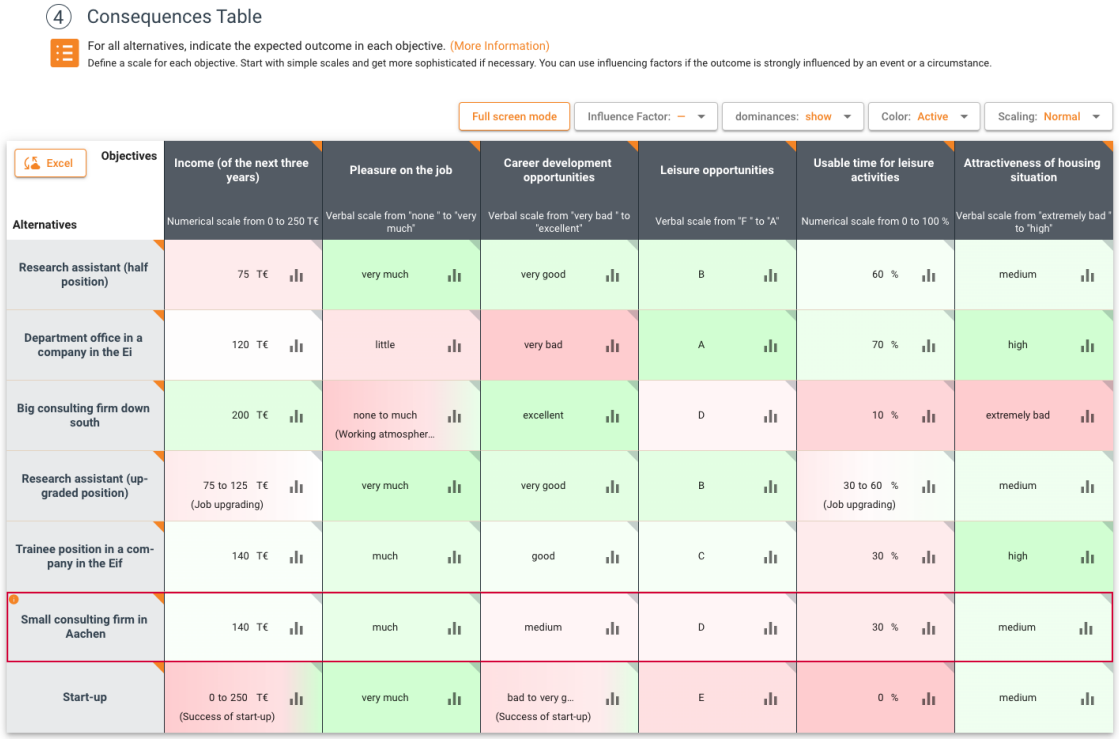

Figure 3.3: Example of a consequences table in Entscheidungsnavi (3).

Zooids (Figure 3.4) introduces dynamic composite physicalizations using self-propelled objects to represent data (4). This technology could be employed in collaborative job-seeking environments to physically visualize different career paths, enhancing decision-making processes through interactive physical representations.

LineUp (Figure 3.5) focuses on the visualization of multi-attribute rankings (5). Its

Figure 3.4: Zooids layout with screen and magnets (4).

capabilities could be invaluable for job seekers who wish to prioritize job opportunities based on multiple criteria such as salary, location, and company reputation. The tool's interactive nature allows for the flexible refinement of parameters, enabling job seekers to explore the effects of different attribute combinations on job rankings.

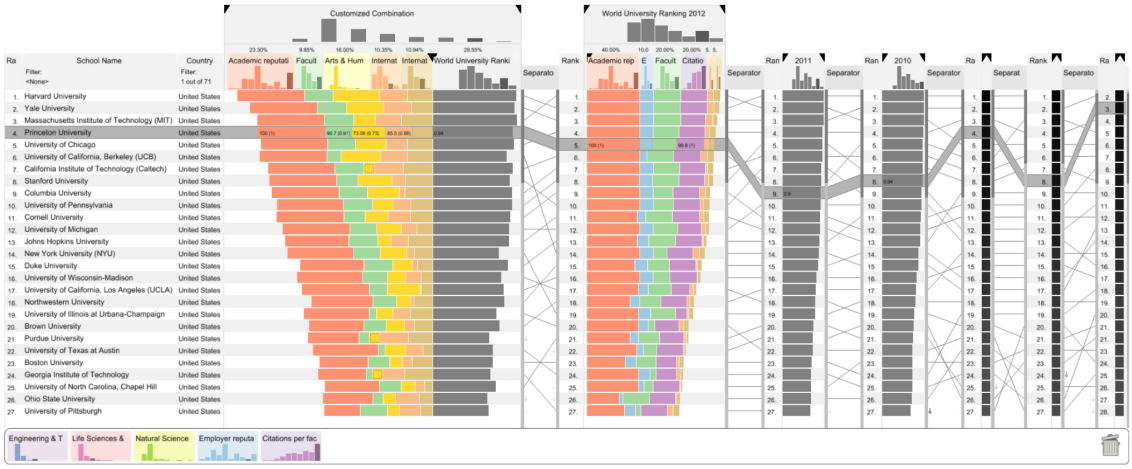

Figure 3.5: LineUp interface (5).

SRVis (Figure 3.6) offers a spatial ranking visualization technique (6). This could be particularly useful for job seekers considering relocation, as it allows for the visualization of job opportunities in different geographical locations, taking into account various spatial contexts essential for decision-making.

AHP Treemaps (Figure 3.7) utilizes treemaps for the Analytical Hierarchy Process (7). This tool could assist job seekers in structuring their decision-making process hierarchically,

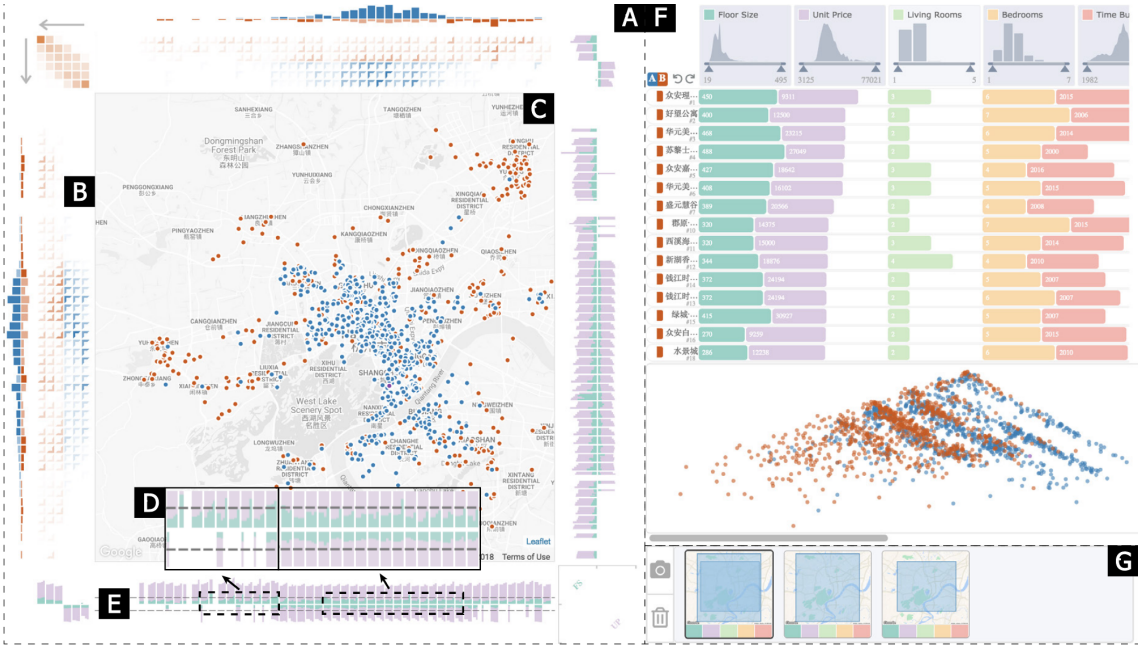

Figure 3.6: The interface of SRVis (6).

helping them to prioritize factors like job role, company culture, and location.

Hi-Trees (Figure 3.8) introduces a new visual representation for hierarchical data (8). This could be employed to visualize and compare career paths in different industries or roles, aiding job seekers in long-term career planning.

Podium (Figure 3.9) focuses on multi-attribute ranking systems (9). It could help job seekers understand which attributes contribute to their subjective preferences for job opportunities, offering a more holistic understanding of the data.

WeightLifter (Figure 3.10) enables visual weight space exploration for multi-criteria decision-making (10). This tool could assist job seekers in understanding the sensitivity of their choices to changes in criteria weights, such as work-life balance or job security.

World Lines (Figure 3.11) provides control over multiple heterogeneous simulation runs (11). This tool could be adapted for job seekers to simulate different career paths or job market scenarios, aiding in the decision-making process by exploring alternative futures.

In summary, while domain-specific tools offer valuable insights and specialized functionalities, their scope is often limited to particular fields or challenges. On the other hand, general-purpose tools provide a versatile foundation that can be adapted to a variety of contexts, including job seeking. Given their broader applicability and potential for customization, the remainder of this thesis will focus exclusively on the analysis of general-

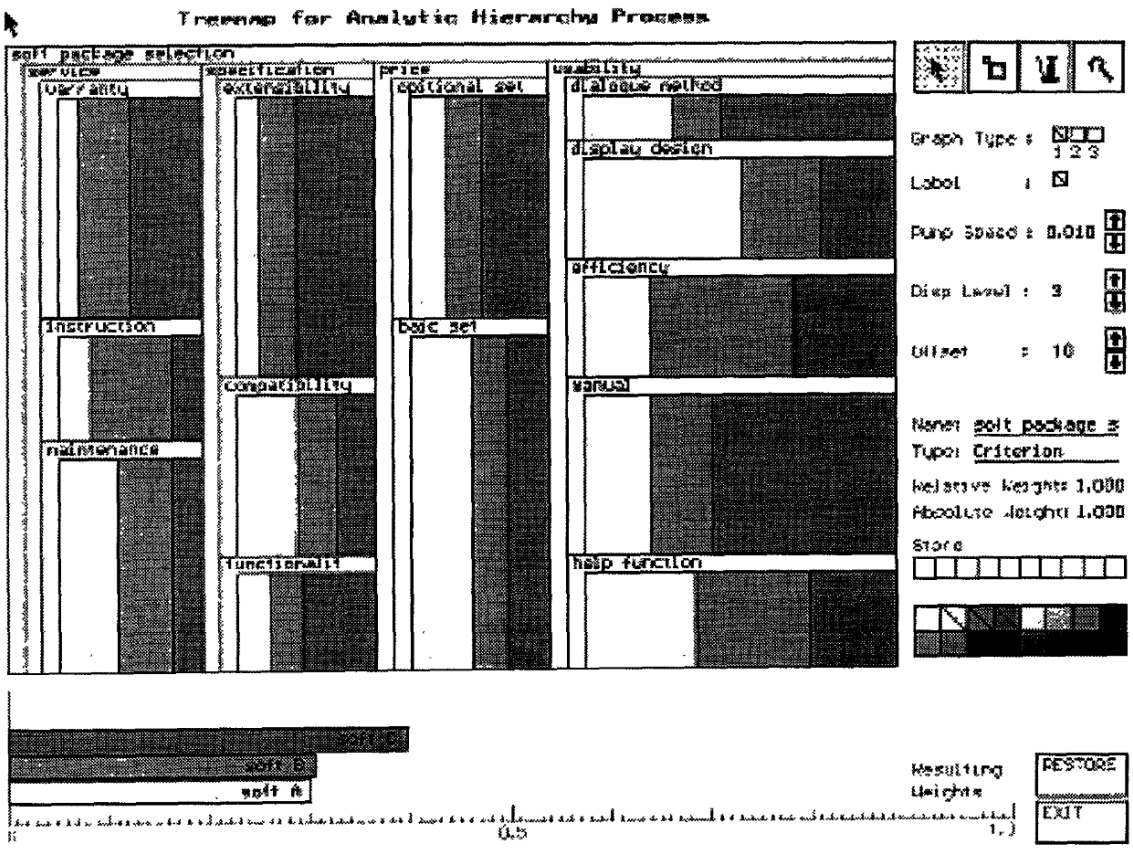

Figure 3.7: Treemap representation Analytical Hierarchy Process (7).

purpose tools. This decision is motivated by the aim of identifying flexible and adaptable visualization solutions that can cater to the diverse and evolving needs of job seekers.

3.2.2 Data and Operation Types in General-Purpose Tools

The general-purpose tools under consideration offer a wide array of functionalities that can be adapted to various data types and operations commonly encountered in job seeking. This subsection aims to explore how these tools can be employed to handle the specific data and operations relevant to job seekers.

3.2.2.1 Data Types

This section examines data types of general-purpose tools, aimed at addressing the specific needs of job seekers in these fields. It concentrates on various data types essential in these domains, such as categorical, ordinal, and quantitative data. Table 3.1 methodically

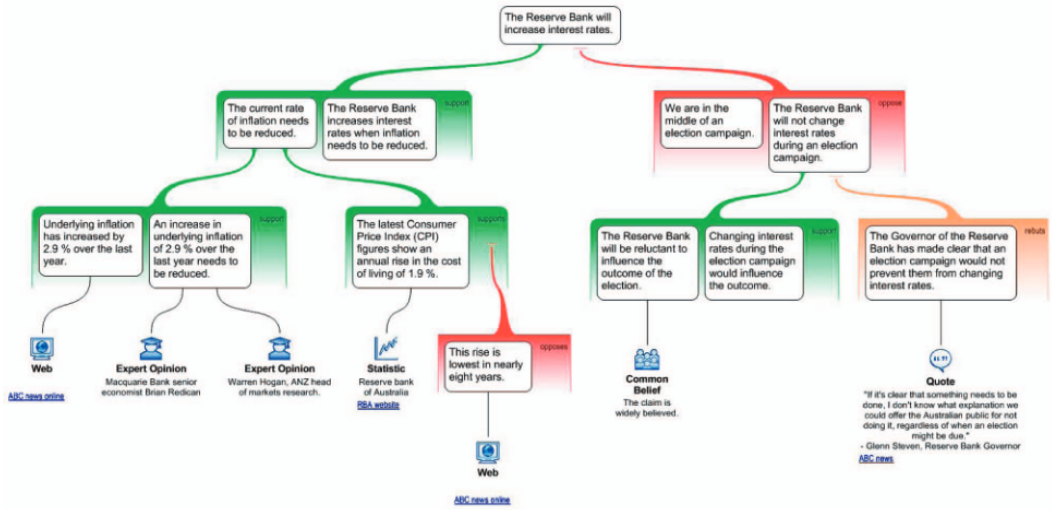

Figure 3.8: Example argument map with Hi-Trees (8).

catalogs these tools according to their data-handling capabilities, providing a streamlined overview that is both informative and accessible for job seekers.

Paper	Categorical Data	Ordinal Data	Quantitative Data	Hierarchical Data	Spatial Data	Temporal Data
LineUp	Yes	Yes	Yes	No	No	No
Entscheidungsnavi	Yes	Yes	Yes	Yes	No	No
Zooids	Yes	Yes	Yes	No	Yes	Yes
Hi-Trees	No	No	No	Yes	No	No
Podium	Yes	Yes	Yes	No	No	No
SRVis	No	Yes	Yes	No	Yes	No
AHP Treemaps	No	No	No	Yes	No	No
WeightLifter	No	No	Yes	No	No	No
World Lines	No	No	Yes	No	No	Yes

Table 3.1: Data Types Handled by Each Tool.

3.2.2.2 Operation Types

The efficacy of tools in data visualization and decision-making is largely determined by their operational capabilities, which define how users interact with data and extract meaningful insights. Understanding these operation types is particularly crucial for job seekers in the data visualization and decision-making domains, as it directly impacts their ability to analyze and interpret data effectively in real-world scenarios. This section discusses

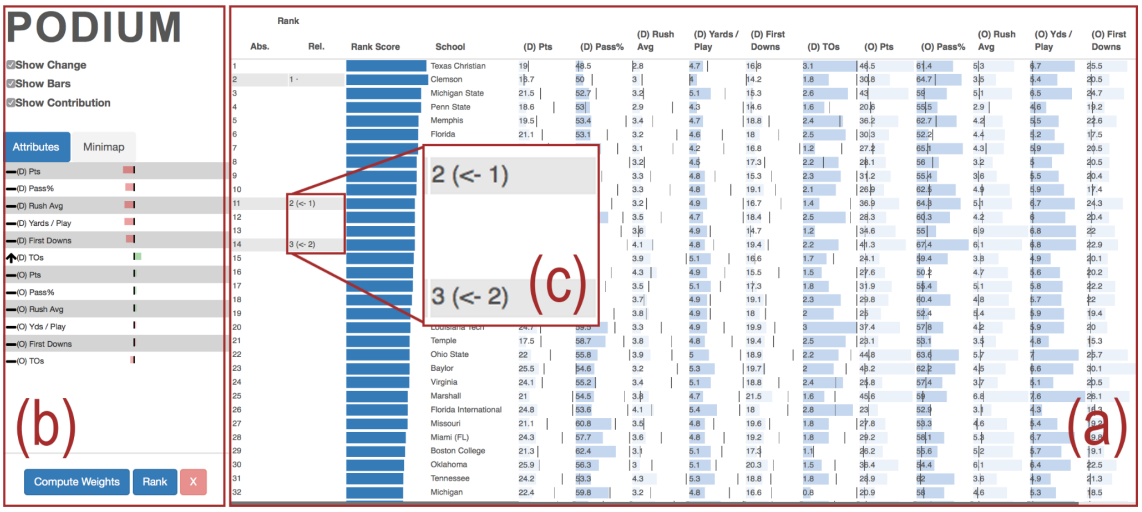

Figure 3.9: Podium interface (9).

specific functionalities and operational aspects of each tool. These detailed insights into the operation types of each tool will equip job seekers with a deeper understanding of how these tools can be applied in various professional contexts, thereby enhancing their job readiness and potential for career advancement in these dynamic fields.

LineUp LineUp is adept in multi-attribute data visualization and ranking. It allows users to dynamically assign and adjust weights to various attributes, which is crucial for job seekers in evaluating job opportunities based on multiple factors like industry, company size, role requirements, and expected salary. Its interactive ranking system enables users to understand how different attributes impact the overall ranking, aiding in decision-making.

Entscheidungsnavi Entscheidungsnavi facilitates structured decision-making with its focus on multi-criteria analysis. It guides users through identifying decision criteria, assigning importance to each criterion, and comparing alternatives. For job seekers, this is particularly useful in systematically evaluating various job offers, taking into account diverse aspects such as job location, career growth opportunities, and work environment.

Zooids Zooids offers an innovative approach to data visualization through physicalization, making it useful for job seekers. It can represent dynamic data such as fluctuating job market demands or changing employment rates across different industries. This interactive tool helps in visualizing and understanding data in a tangible way, aiding in strategic job search planning.

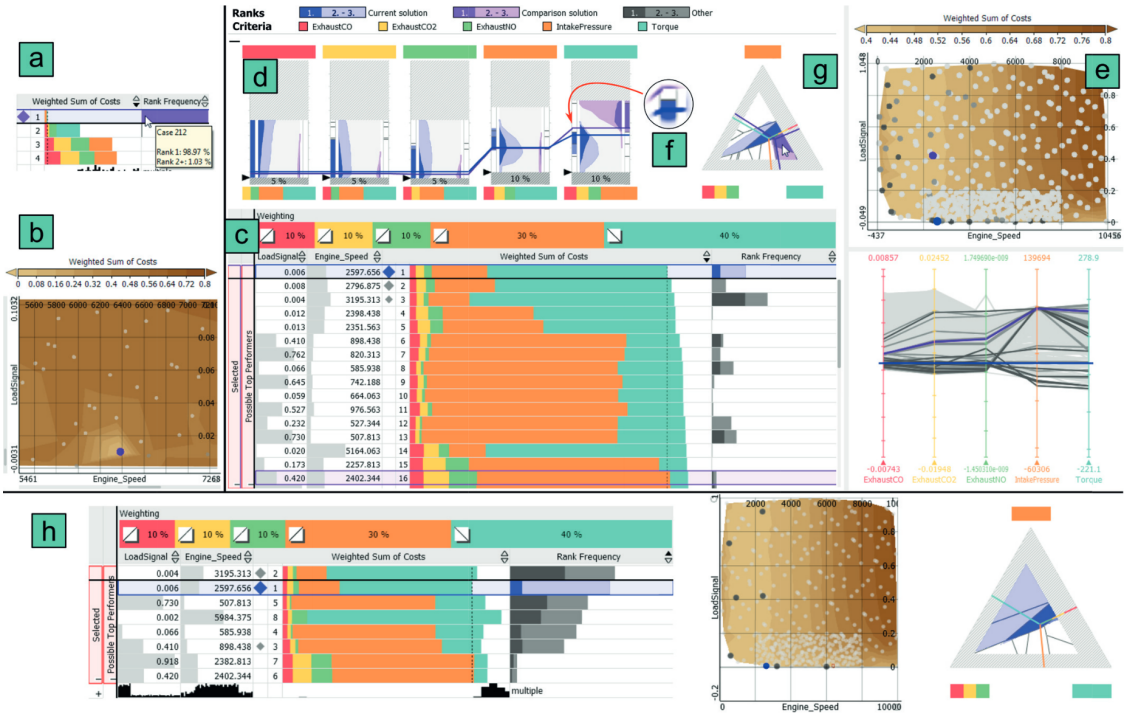

Figure 3.10: WeightLifter interface (10).

Hi-Trees Hi-Trees specializes in visualizing hierarchical structures, making it suitable for job seekers to map potential career paths or analyze organizational hierarchies of companies. It can help in understanding the progression routes within a company or industry, highlighting potential growth opportunities and career advancements.

Podium Podium focuses on ranking data based on user-defined weights, beneficial for job seekers in prioritizing job listings. Users can rank jobs based on criteria such as salary, job security, or proximity to home, helping them to make more informed decisions about which job offers to pursue.

SRVis SRVis is tailored for spatial ranking visualization. It is particularly useful for job seekers who need to consider geographic locations in their job search. This tool can visualize job opportunities on a map, allowing for spatial comparisons, such as proximity to certain amenities or commute times.

AHP Treemaps AHP Treemaps facilitate visual decision-making in hierarchical formats. This tool is particularly useful for job seekers in breaking down complex decisions,

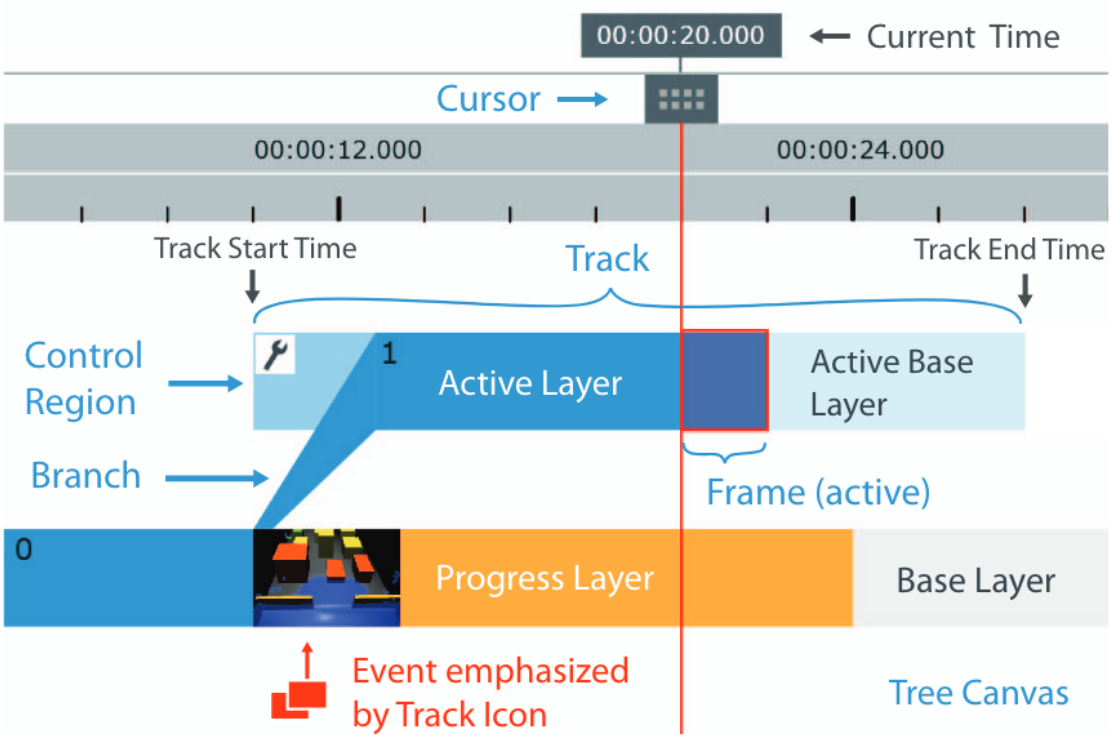

Figure 3.11: Visual elements of World Lines (11).

like choosing between different job sectors or navigating career changes, into simpler, more manageable hierarchical steps.

WeightLifter WeightLifter excels in exploring weight spaces in decision-making, which can assist job seekers in balancing various factors such as job role, company culture, salary expectations, and location preferences. It allows for a nuanced understanding of how changing one's priorities can influence the overall decision-making process.

World Lines World Lines is innovative in visualizing multiple simulation runs, ideal for job seekers exploring different career scenarios. This tool can simulate various career trajectories based on different decisions, such as the impact of further education on career prospects or changing industries, and helps visualize the outcomes of these paths.

Each of these tools equips job seekers with unique functionalities and insights, enhancing their ability to make data-driven decisions and plan their careers strategically in a competitive job market.

3.2.3 Visual Encodings

The way data is visually presented can significantly influence its interpretation and understanding. This is particularly true in the realm of data visualization tools, where visual encodings transform raw data into a comprehensible visual format. For job seekers in data-centric fields, proficiency in understanding and leveraging these visual encodings is crucial for effective data analysis and decision-making.

LineUp LineUp employs a unique visual encoding scheme that utilizes bar charts and color gradients to represent multi-attribute data (Figure 3.5). Each attribute in a dataset is encoded as a column in a table, where bar lengths and colors depict the magnitude and category of data, respectively. This approach enables job seekers to visually compare and rank different job listings based on various criteria such as salary range, company rating, and job location.

Entscheidungsnavi Entscheidungsnavi uses structured decision trees and matrix-based visualizations (Figure 3.3). Each decision criterion and its alternatives are visually encoded in a tree structure, providing a clear hierarchical view of decision factors. This is particularly helpful for job seekers in mapping out complex decision processes, like evaluating various job offers or career paths.

Zooids Zooids introduce physical objects as data representations, offering a tangible interaction with data points (Figure 3.4). Each 'Zooid' robot represents a different data element or attribute, moving and organizing in physical space to demonstrate data trends, patterns, and relationships. For job seekers, this could translate into an interactive, physical representation of job market trends or skill requirements.

Hi-Trees Hi-Trees visualize hierarchical data through tree diagrams, where each node represents a data element, and connections between nodes depict relationships (Figure 3.8). This structure is particularly effective for job seekers to visualize organizational structures or career progression paths within industries or companies.

Podium Podium uses an interactive table layout with draggable rows for ranking data (Figure 3.9). Each row represents a different job or company, and users can rearrange these based on personal preferences or criteria weights. This allows job seekers to prioritize job listings visually and make comparative assessments.

SRVis SRVis specializes in spatial data visualization, employing maps and geographical layouts to represent data points (Figure 3.6). For job seekers, this could mean visualizing job opportunities on a map, highlighting areas with high demand,or visualizing spatial distributions of industry sectors.

AHP Treemaps AHP Treemaps uses treemaps to represent hierarchical decision-making data (Figure 3.7). Different criteria and sub-criteria are encoded in nested rectangles of varying sizes and colors, providing an intuitive visual breakdown of complex decision-making processes.

WeightLifter WeightLifter visualizes multi-criteria weight spaces using a combination of sliders, graphs, and color-coded regions (Figure 3.10). This allows job seekers to understand how varying the importance of different job aspects (like work-life balance or salary) can affect their overall job decision process.

World Lines World Lines employs a unique visual encoding using lines and branching paths to represent different simulation outcomes over time (Figure 3.4). This approach allows job seekers to explore various career scenarios and their potential outcomes, with each line representing a different career path or decision trajectory.

Each tool's visual encoding mechanisms offer distinct advantages in data representation, aiding job seekers in comprehending complex data sets and making informed decisions based on their career goals. In summary, the visual encoding techniques offered by these general-purpose tools are diverse and innovative, each providing unique ways to interpret and interact with data.

3.2.4 Algorithmic Underpinnings

The algorithmic underpinnings of general-purpose tools are essential for understanding their performance, scalability, and adaptability. This section delves into the computational algorithms that these tools employ, isolating them from their functional aspects discussed in previous sections.

Computational Complexity

LineUp, *Podium*, and *SRVis*, employ ranking algorithms that operate in polynomial time, making them scalable for large datasets, a crucial factor for job seekers dealing with extensive job listings (5, 6, 9).

Quad-trees

SRVis uses spatial data structures like quad-trees to efficiently handle geographical data, which could be useful for job seekers considering multiple locations (6).

Optimization Techniques

WeightLifter uses a linear programming optimization framework to find the best weight combinations for multi-criteria decision-making, which could be adapted to optimize job selection criteria (10).

Simulation and Probabilistic Models

World Lines employs Monte Carlo simulation techniques to explore multiple scenarios, which could be useful for job seekers to simulate different career paths or job market trends (11).

Real-Time Algorithms

Zooids uses real-time tracking algorithms to control self-propelled objects, introducing a new dimension of real-time interaction that could be useful in collaborative job-seeking scenarios (4).

Hierarchical Processing

Both *AHP Treemaps* and *Hi-Trees* use tree-based data structures for hierarchical data representation, which could be useful for job seekers to organize and prioritize their job search criteria (7, 8).

In summary, the algorithmic underpinnings of these general-purpose tools are designed for efficiency, scalability, and adaptability, making them potentially suitable for the computational demands of job-seeking tasks.

3.2.5 Gap Analysis

The current landscape of MCDM visualization tools reveals a conspicuous absence of domain-specific solutions tailored exclusively for job-seeking experience. While various tools cater to specialized sectors or challenges, there's a noticeable void when it comes to tools designed with the unique requirements and complexities of job seeking in mind. This gap underscores the need for a dedicated tool that can holistically address the multifaceted needs of job seekers.

General-purpose tools, such as *LineUp*, *Podium*, and *Zooids*, offer a broad range of functionalities that hold potential for adaptation to the job-seeking context (4, 5, 9). Their versatility suggests that, with appropriate customization, they could be harnessed to visualize and analyze job opportunities and other relevant data. Tools like *AHP Treemaps* and *Hi-Trees* could be repurposed to visualize hierarchical structures like career paths or organizational hierarchies (7, 8).

Despite the potential applicability of general-purpose tools, a significant limitation emerges when considering the inclusion of qualitative criteria essential for job seekers. While these tools are adept at handling quantitative data, they often fall short in capturing and representing non-numeric aspects such as cultural fit, work-life balance, and personal growth opportunities. Such qualitative factors, although intangible, play a pivotal role in a job seeker's decision-making process. The current tools' inability to effectively visualize or prioritize these qualitative dimensions highlights a pressing need for innovation and refinement in this domain.

In summary, while the current array of visualization tools offers a foundation, there's a clear demand for more specialized, domain-specific tools for job seeking. These tools should not only be versatile but also adept at capturing the nuanced qualitative criteria that significantly influence job seekers' decisions.

4

Understanding job seeker's needs and preferences

The complexity and evolving nature of the job-seeking process highlights the necessity for tools and resources that could effectively assist job seekers. While existing visualization tools lay the groundwork, there's a gap where a more personalized approach could offer substantial improvements. In this context, interviews with job seekers offer an essential opportunity to directly engage with their experiences, challenges, and aspirations. The interview process was structured around three key objectives:

1. To explore both quantitative and qualitative criteria influencing job selection decisions, to provide a comprehensive understanding of the various factors impacting job seekers' choices.

2. To identify the types of guidance and support job seekers find most beneficial, pinpointing deficiencies in current resources and proposing possible enhancements.

3. To delve into the details of the job seekers' experiences, focusing on their specific visualization needs and preferences during the job search process.

Cumulatively, these objectives are designed to offer a thorough understanding of the job search experience, thereby informing the development of tools and resources that truly align with the nuanced needs of job seekers.

4.1 Methodology

To gain a deeper understanding of the unique visualization needs and preferences of job seekers, a series of structured interviews were conducted. This approach was chosen to en-

sure a comprehensive and systematic exploration of job seekers' behaviors and requirements and apply them to design a novel job seeking tool. Through these interviews, insights were gathered directly from the target audience, providing valuable perspectives on their experiences and challenges in navigating the job search process. This methodological choice was instrumental in identifying key factors that influence job seekers' decision-making, thereby informing the development of more effective visualization tools tailored to their specific needs.

4.1.1 Participants

A total of six participants were involved in this study, all of whom had actively engaged in job searching within the past year. The participants ranged in age from 18 to 55 years. Four identified as female, two as male. In terms of educational background, two held a bachelor's degree, and four had a master's degree. The majority (five particpants) had more than one year of professional experience.

All participants were provided with a consent form with detailed information about the interview, detailing the purpose of the study, the nature of their involvement, and potential risks. They were given time to review this information and ask questions. Following this, written or recorded informed consent was obtained from each participant before commencing the interview.

To safeguard participants' privacy, all personal identifiers were removed or anonymized in the data. Each participant was assigned a unique code, and only this code was used during data analysis. All recordings and transcripts are stored securely, with access restricted to the researcher. Participants were also assured that any published findings would be anatomized, ensuring individual anonymity.

4.1.2 Data Collection

Data was collected through semi-structured interviews using the critical intent technique(76). Each interview was recorded and took approximately 45-60 minutes and was conducted in person or via Google Meets. The interview protocol comprises warm-up questions, critical incident-based questions related to the three primary research questions, and closing questions. Demographic data was collected to provide context to the participants' responses. The interview protocol can be found in Appendix A.

4.1.3 Data analysis

Data analysis started with transcribing interviews verbatim with MS Word and then manually correcting them. This study employed a qualitative research design, using thematic analysis to interpret the data collected from interviews. The choice of thematic analysis was guided by its flexibility and its ability to provide a rich and detailed, yet complex account of data (77).

Initial Coding

The analysis process began with the generation of initial codes. These codes were developed inductively from the data, staying close to the participants' words and experiences. Examples of some of the initial codes are listed in Table 4.1.

No.	Item
1	Job Search Channels
2	Job Search Criteria
3	Decision-Making Factors
4	Challenges and Difficulties
5	Decision-Making Guidance
6	MCDM Usage
7	Visualization Techniques
8	Job Search Outcomes
9	Job Search Frequency
10	Suggestions for Improvement

Table 4.1: Initial codes

The initial codes encompassed a wide range of topics, including the mechanisms used for job searching, the criteria for selecting potential jobs, the factors influencing decision-making, the challenges encountered during the job search, and the sources of guidance for decision-making, among others.

Hybrid Thematic Analysis: Integrating Inductive and Deductive Coding

The analysis process followed a hybrid approach of inductive and deductive coding and theme development, as suggested by Fereday and Muir-Cochrane (78) which was done in MS Excel. The themes were reviewed and refined in an iterative process, ensuring they accurately represented the coded data. This involved a constant movement back and forth

between the entire data set, the coded extracts of data, and the analysis of the themes (79).

In the process, the codes were tagged with different labels like 'number' or 'not a number' to categorize them as different types of criteria. Secondly, the data was coded with different factors, emotions, goals, and tools which would give a more accurate representation of the data. After several back-and-forth coding themes emerged that relate to the current research goal.

Naming Themes

The final step involved defining and naming the themes. Each theme was defined in a way that identified its scope and distinguished it from other themes. This process of defining and refining themes ensured a clear and identifiable thematic 'story' that related back to the research question and literature (80).

The use of thematic analysis in this study allowed for a rich exploration of the interview data, providing a detailed and nuanced understanding of the participants' experiences and perspectives. The findings from this analysis are presented in the following section.

4.2 Results

This section presents the findings from our study, which was focused on a comprehensive understanding of the job search process. The primary objective was to explore both quantitative and qualitative criteria that influence job selection decisions, aiming to provide a holistic view of the various elements that impact job seekers' choices. The second objective was to identify the types of guidance and support job seekers require, pinpointing gaps in current resources and suggesting improvements. The third objective sought insights vital for the development and enhancement of a prototype tool tailored for job seekers. This involved evaluating the effectiveness of existing tools and understanding the specific needs and preferences of job seekers to inform the design and functionality of the proposed design. Collectively, these objectives aimed to deepen our understanding of the job search experience and contribute to the development of more effective support mechanisms and tools for job seekers.

4.2.1 Thematic analysis results - Understanding the Modern Job Seeker

The results presented in this section provide insights into the experiences, challenges, and preferences of individuals during their job search process. The findings are organized into

four distinct themes that emerged from the analysis, each shedding light on different facets of the job search experience.

4.2.1.1 Theme 1: Identity and Aspirations - Profiling the Job Seeker

The modern job market is a dynamic landscape, shaped by evolving industry trends, technological advancements, and individual aspirations. To navigate this terrain, it's imperative to understand the identity and aspirations of job seekers. Participants' insights offer a window into their perspectives on the job market, career trajectories, and aspirations.

Current Job Landscape The process of securing a job in today's market is multifaceted. Digital platforms, such as online job portals, have become integral to the job search process, as highlighted by Participant P6's reliance on Glassdoor. This digital shift underscores the evolving nature of job acquisition in the modern era.

Diverse Career Aspirations Participants exhibited varied career goals, reflecting the diverse aspirations of job seekers. While some, like Participant P3, sought transitions within industries, others aimed for vertical growth, emphasizing the individualized nature of career trajectories.

4.2.1.2 Theme 2: Decision Dynamics - Navigating Job Opportunities

Job selection is a nuanced process, influenced by a myriad of factors. Participants' insights reveal the significance of both quantitative and qualitative criteria in shaping their decisions, emphasizing the multifaceted nature of job evaluation.

Beyond Basics While traditional factors like salary continue to be crucial, there's a notable shift in the job-seeking paradigm towards more holistic evaluations. Modern job seekers are placing greater importance on qualitative aspects such as company values, team dynamics, and personal development opportunities. This trend highlights the evolving priorities of today's workforce.

In the current job market landscape, decisions are increasingly influenced by values-driven considerations. As highlighted by Participant P2, "I would look into what are the values of the company. Do they match my own values?" This sentiment, shared by others, emphasizes the significance of cultural fit, organizational ethos, and the alignment of personal and professional values. This transformation underlines the critical role of qualitative criteria in guiding the choices of contemporary job seekers.

4.2.1.3 Theme 3: Navigating Hurdles - Challenges in the Job Search

The journey of job searching is fraught with challenges. Participants' experiences shed light on the emotional, logistical, and practical hurdles they encounter, emphasizing the complexities of the modern job search.

Emotional Strain The emotional toll of job searching, marked by feelings of being lost, low response rates, and frequent rejections, underscores the psychological challenges inherent in the process. One of the contributors to that is the lack of understanding of job descriptions. P2 stated, "I found it quite complex in terms of like just knowing how to understand what they were actually wanting me to do."

Seeking Guidance In the face of challenges, job seekers often turn to various sources for guidance. Participants mentioned several different sources of guidance like reflective conversations with peers, insights from personal relationships, or leveraging digital tools.

4.2.1.4 Theme 4: Visualizing Aspirations - Tools for the Modern Job Seeker

Effective visualization tools can streamline the job search process, offering clarity and enhancing the overall experience. Insights from participants highlight the potential of these tools in catering to the unique needs and aspirations of job seekers.

Tool Design: Crafting User-Centric Platforms The design and functionalities of job search tools are crucial in defining the user experience. A user-centric approach, as expressed by participants such as P1 and P4, highlights the desire for platforms that allow personalization, like the ability to add individual profiles. Integrating elements such as personal profiles and diverse job criteria can significantly enhance the resonance of these platforms with the needs of modern job seekers. This personalized approach, catering to the specific preferences and requirements of users, is fundamental in crafting tools that align with the evolving landscape of job searching

Decision-making Process: Visualizing the Journey Visualization tools that capture the multifaceted decision-making process can aid job seekers in making intuitive decisions, providing clarity and structure to their journey. Participant P2's flowchart was a testament to this complexity. The flowchart began with basic criteria and went through different stages of the job-seeking process like "basic criteria", "rank" and "interview stage".

Mental Model: Mapping the Cognitive Landscape Understanding the mental models employed by job seekers can offer invaluable insights for tool design. Visualization tools that mirror these cognitive processes can guide job seekers through the various stages of their journey, offering a structured yet flexible framework. Participant P6's visualization showed a flowchart that went through the process of evaluation of each criteria participant had for a job.

4.3 Discussion of the Results

This discussion aims to contextualize our findings from the interviews within the broader framework of the three research objectives and the themes that emerged, offering insights into the implications for both job seekers and the development of visualization tools.

4.3.1 Aligning Findings with Research Objectives

Objective 1: Holistic Job Selection Criteria The first objective focused on exploring the criteria influencing job selection decisions. The emergent themes, particularly "Identity and Aspirations - Profiling the Job Seeker" and "Decision Dynamics - Navigating Job Opportunities," highlight the complex interplay of both quantitative and qualitative factors in job seekers' decision-making processes. The diverse career aspirations and values-driven decisions reported by participants underscore the need for visualization tools that cater to this multifaceted evaluation process.

Objective 2: Guidance and Support for Job Seekers The second objective sought to identify the guidance and support mechanisms most beneficial to job seekers. The theme "Navigating Hurdles - Challenges in the Job Search" reveals the emotional and practical obstacles job seekers face, while the subtheme "Seeking Guidance" (see 4.2.1.3) emphasizes their reliance on various support systems. These insights point to the necessity for visualization tools that not only aid in decision-making but also provide comprehensive support with analyzing the data and sensemaking throughout the job search journey.

Objective 3: Insights for Prototype Development The third objective aimed to gather insights for the development of a job seeker-focused visualization tool. The theme "Visualizing Aspirations - Tools for the Modern Job Seeker" directly addresses this, with

subthemes like "Tool Design: Crafting User-Centric Platforms" (see 4.2.1.4) and "Decision-making Process: Visualizing the Journey" (see 4.2.1.4) indicating key areas for development. The call for user-centric design and decision-making support in the tools aligns closely with this objective.

4.3.2 Implications of Themes in Context of MCDM Visualization Tools

Modern Job Seeker Needs and Tool Development The integration of digital platforms in job searching, as evidenced by the theme "Identity and Aspirations," indicates a shift towards more personalized and interactive job search experiences. The findings, particularly under "Decision Dynamics," suggest that current MCDM visualization tools may not fully capture the qualitative criteria important to job seekers. This gap reinforces the necessity for developing dedicated visualization tools that balance both quantitative and qualitative aspects of job opportunities.

Addressing the Gaps and Future Directions The thematic insights, especially from "Navigating Hurdles" and "Visualizing Aspirations," provide a clear direction for the enhancement of visualization tools. A dedicated tool should ideally offer an intuitive interface that supports job seekers in navigating the complexities of the job market, addressing both the emotional and practical aspects of their journey.

4.3.3 Design Implications from Study Insights and Future Research Directions

The study's results, in alignment with the identified objectives and emergent themes, underscore a significant opportunity for innovation in the realm of Multi-Criteria Decision Making (MCDM) visualization tools tailored to job search processes. The insights gained will be pivotal in informing the design section that follows, ensuring the development of a prototype that is both reflective of the current job search landscape and anticipatory of future needs.

Key insights to be incorporated into the design phase include:

1. **Integration of Quantitative and Qualitative Criteria:** Incorporating mechanisms for evaluating both quantitative aspects (like salary, location) and qualitative aspects (such as company culture, and work-life balance).

2. **User-Centric Design Approach:** Prioritizing user experience, ensuring the tool is intuitive, engaging, and responsive to the varied needs of job seekers.

3. **Support Mechanisms for Decision Making:** Including features that offer guidance and support, aiding job seekers in making informed decisions amidst the complexities of the job market.

4. **Flexible and Adaptive Interface:** Featuring a flexible interface that adapts to individual user preferences.

5. **Interactive Visualization Techniques:** Utilizing advanced visualization techniques to present job-related data in a more engaging and easily digestible format.

6. **Empathetic Design Considerations:** Incorporating elements that are empathetic to the user's psychological state, offering a more comforting and reassuring user experience.

These insights will guide the development of a prototype that is not only functionally robust but also resonant with the real-world needs and preferences of job seekers.

5

Design

In today's dynamic job search environment, there's a significant need for Multi-Criteria Decision-Making (MCDM) visualization tools that effectively meet the requirements of job seekers. Based on a thorough analysis of existing literature and insights from interviews, it's evident that current MCDM tools for job searching do not fully address the complex needs of users. This chapter focuses on the essential design features necessary to fill these gaps. The aim is to create a user-friendly, intuitive, and comprehensive tool that aligns with the needs of modern job seekers.

5.1 Design Requirements

The design of the visualization tool for job seekers is predicated on a comprehensive understanding of their needs, preferences, and behaviors. These requirements are informed by insights gathered from interviews as detailed in Chapter 4, and a review of current MCDM tools as outlined in Chapter 3. The tool is envisioned to be not only informative but also engaging, allowing users to interact meaningfully with their job search process. The following are the detailed requirements:

1. **DRI - Qualitative Data Integration:** A one-stop shop for all job-related information is essential for a holistic job search approach. As such, the tool will integrate diverse job-related data.

2. **DRII - User-Centric Interface:** The interface should be intuitive and user-friendly, reducing cognitive load and focusing on a seamless user experience. This aligns with the need for stress-free interaction identified in 4.2.1.4.

3. **DRIII - Flexible Weighting System:** Personalization of job attributes through a flexible weighting system will allow users to customize their search according to their individual priorities, respecting the diverse job seeker needs discussed in Chapter 3.

4. **DRIV - Visual Clarity:** To effectively process vast amounts of data, the tool will employ clear and concise visual elements to enable quick and easy comparison of job opportunities, addressing the cognitive overload problem identified in 4.2.1.4.

5. **DRV - Scalability:** The tool must be able to handle an increasing number of job listings and user interactions without a drop in performance. General requirements emerging from 3.1.2.

6. **DRVI - Interactive Decision-Making Support:** Interactive elements will be incorporated to assist users in their decision-making process, providing proactive guidance in navigating job opportunities, a need that emerged from user feedback in 4.2.1.4.

Each design requirement has been crafted with careful consideration to meet the specific needs and challenges identified by job seekers. The implementation of these features will ensure that the visualization tool is not only functional but also enhances the job search experience.

5.1.1 Interaction Requirements

The interaction model of the visualization tool is predicated on the seven categories of interaction identified by Yi et al. (81), which are fundamental for an effective information visualization experience. Each category is transformed into a requirement that our system must fulfill to support the job-seeking process adequately.

1. **Select:** The system shall allow users to select and highlight specific data points, such as job listings or company information, for further interaction or detailed viewing.

2. **Explore:** The system shall enable users to explore the job listings by navigating through different views of data and varying levels of detail without losing context or orientation.

3. **Reconfigure:** The system shall provide mechanisms for users to reconfigure the presentation of the data by changing how the information is organized and displayed to reveal patterns and relationships.

4. **Encode:** The system shall permit users to encode data by choosing from a suite of visual representations that best convey the information's salient features (e.g., bar charts for salary ranges).

5. **Abstract/Elaborate:** The system shall support abstracting and elaborating operations by allowing users to adjust the level of detail displayed in the data visualization, from highly summarized to very detailed.

6. **Filter:** The system shall provide filtering functions to enable users to focus on a subset of job listings that meet their criteria while disregarding irrelevant data.

7. **Connect:** The system shall support the discovery of relationships and connections between different data types.

These interaction requirements form the core of the system's functionality and establish the foundation for a comprehensive and user-centered tool that aligns with the cognitive and analytical needs of job seekers.

5.2 Design Rationale

This section elaborates on the envisioned interactions and design features of the job-seeking visualization tool, particularly focusing on how these elements respond to the articulated needs of job seekers. The design is informed by existing solutions, like Lineup, and improved upon to fulfill specific user requirements. The visualization tool designed part of this research addresses the requirements DRI - DRV.

However, the requirement DRVI - Interactive Decision-Making Support, which involves incorporating interactive elements for proactive guidance in navigating job opportunities, falls outside the scope of this tool's design. This is due to several factors: Firstly, the complexity and scope required for interactive decision-making support exceed the primary function of the tool, which is to present data and facilitate understanding. Secondly, the tool's design focuses on empowering users with information, maintaining user autonomy in decision-making, and avoiding overly directive features that could undermine this autonomy. Thirdly, the technical limitations of integrating advanced interactive features demand resources and expertise beyond the current thesis's scope. Therefore, while interactive decision-making support has its merits, integrating it into the current visualization tool design is impractical due to these considerations related to complexity, user autonomy, technical feasibility, and project constraints.

The design of the tool encompasses multiple components, including a profile section (refer to section 5.2.3), a Qualitative Criteria Quantifier section (see section 5.2.2), and integration with LineUp (outlined in section 5.2.1). To enhance interface usability, the design adopts the F-shaped layout, a proven approach for user-friendly digital interfaces, as identified in the study by Shirogane (82). This structure facilitates intuitive navigation and efficient information processing for users.

5.2.1 Integration with LineUp

LineUp (5) stands as a proficient tool, primarily catering to quantitative dimensions of data analysis and visualization (Figure 5.1). LineUp serves as a base that fulfills the design requirements from DRII to DRV and all seven interaction requirements. Its strength lies in its systematic approach to filtering and ranking based on different attributes. This capability makes it an advantageous starting point for constructing a job search tool that can manage and visualize a large dataset of job opportunities with efficiency and precision. While LineUp does not apply one specific MCDM method, it allows the handling of multiple attributes with different weights, reflecting their importance in the overall evaluation. This feature is particularly useful in the context of a job search tool, where varying factors such as salary, location, company size, and job role might hold different levels of importance for different users. LineUp has served as a foundational basis for the development of several other tools (83, 84).

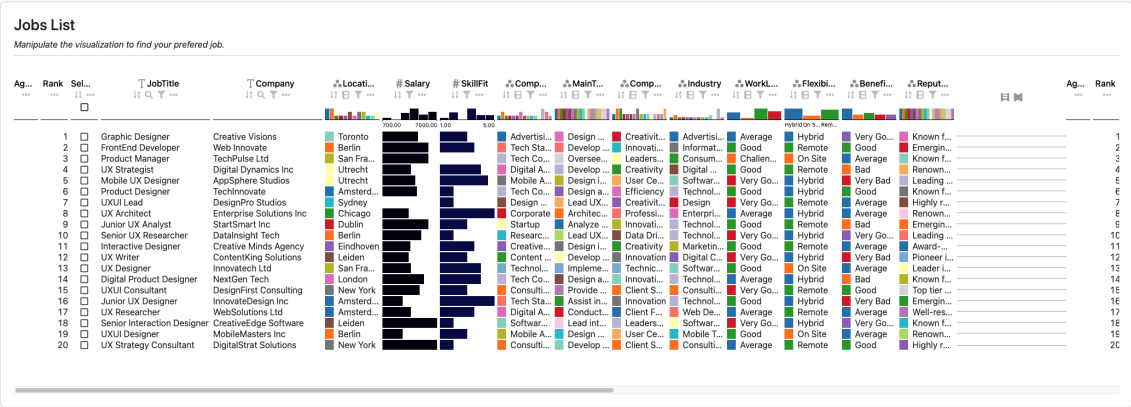

Figure 5.1: LineUp interface in the tool.

Nevertheless, insights from user interviews indicate a significant amount of qualitative attributes in the job-seeking process. Attributes such as company culture, potential for professional development, and work-life balance are not only secondary metrics but are

often pivotal in decision-making for job seekers. These aspects, though not traditionally quantifiable, carry considerable weight and influence the attractiveness of a job listing.

The existing implementation of LineUp utilizes these qualitative aspects merely at a filtering level, providing a binary inclusion or exclusion in the dataset. This basic application fails to capture the subtle gradations and nuances that job seekers use to evaluate potential employers which makes it not fulfill DRI. To address this gap, the thesis proposes an additional functionality to LineUp to incorporate the qualitative criteria to Lineup as scores.

5.2.2 Qualitative Criteria Quantifier

To serve DRI, this thesis proposes an additional functionality to LineUp in the form of a Qualitative Criteria Quantifier (Figure 5.2), a dynamic and user-centric metric assigned through the implementation of Attribute Scoring Functions (ASFs) (85). This system empowers job seekers to personalize their job search by assigning scores to job attributes based on their individual preferences for categorical data.

5.2.2.1 Creation of ASFs for Categorical Attributes

Non-equidistant ASFs allow users to express their preferences relative to each other. Categories are displayed as points on a two-dimensional plane, and users can place these points along an axis representing their preferred degree. The non-equidistant ASF offers more granularity, enabling users to specify the degree of preference more precisely. The ranking visualization base has been applied similarly to RankASco (86).

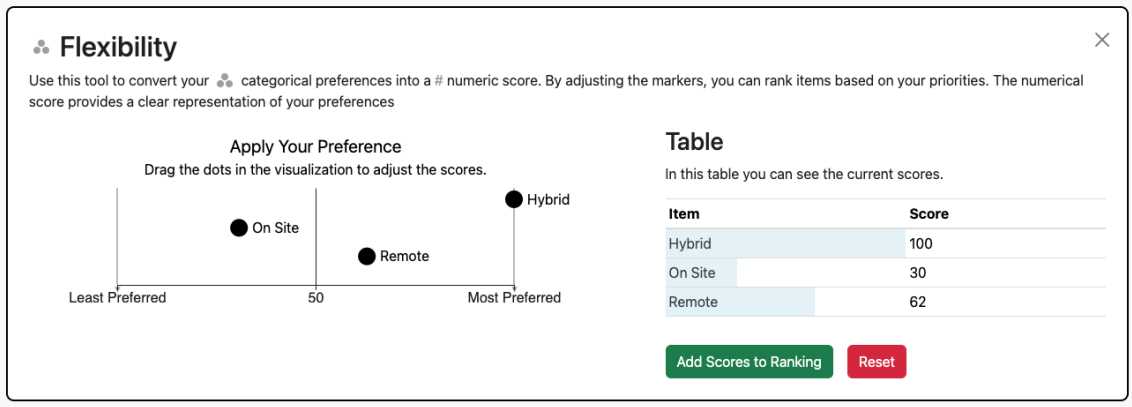

Figure 5.2: Design of the Qualitative Criteria Quantifier where users can adjust their preferences. Example of Flexibility of work.

5.2.2.2 Design and Interaction

The interface is comprised of a straightforward, two-part layout: an interactive visualization for input and a table for immediate feedback. Interactive Visualization: This section operates on a horizontal axis labeled from 'Least Preferred' to 'Most Preferred'. In the example (Figure 5.2 seen above), the users can set their preference for job flexibility options—'On Site', 'Hybrid', and 'Remote'—by dragging corresponding markers along the axis. This interaction is intuitive, allowing users to adjust their preferences tangibly and visually. Each category—represented by a dot in the visualization—is placed on a scale that quantifies the user's preference, with the ability to assign a numeric score directly through this interaction. Adjacent to the visualization is a table that lists the current scores for each category. As users adjust their preferences on the interactive axis, the scores update in real-time, reinforcing the impact of their actions.

Using the job Flexibility example as in Figure 5.2, 2 scenarios will illustrate how user preference can affect the score as shown in Figure 5.5.

5.2.2.3 Integration into LineUp

Upon adjusting the markers to reflect their preferences, users can apply these scores to the overall ranking of job listings. This is done through the 'Add Scores to Ranking' button, which translates these categorical preferences into a numerical score that will be included in the LineUp as seen in Figure 5.3. The interface also allows users to reset their input to default settings, providing a convenient way to start the scoring process anew if their preferences change.

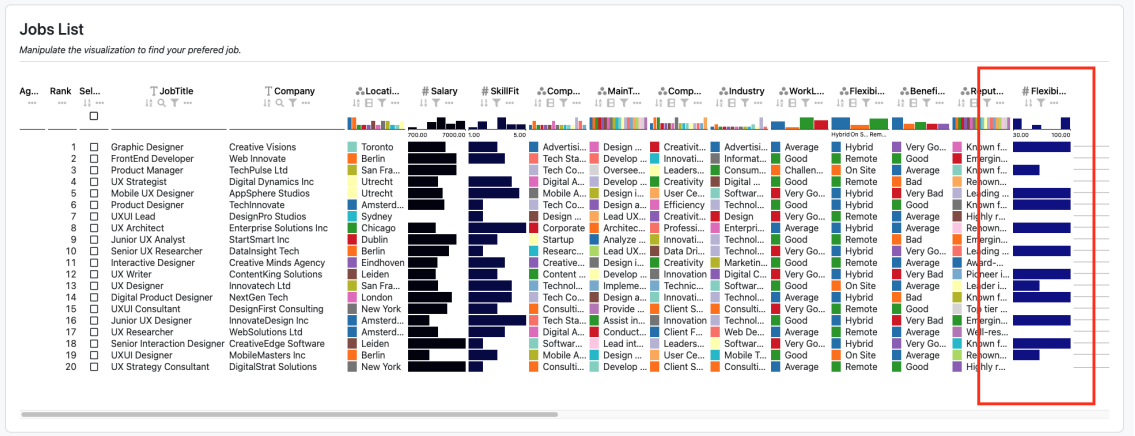

Figure 5.3: Added scores in the LineUp view.

5.2.2.4 Enhanced Decision-Making Through Visual Analytics

This design encourages users to actively engage with their job search criteria, turning abstract preferences into concrete, actionable data points. By visually encoding categorical preferences into a numeric score, the tool bridges the gap between subjective inclination and objective evaluation, fostering a more data-driven job selection process. The dual-component interface not only simplifies the complexity of personal preference articulation but also provides immediate, visual validation of the user's choices, enhancing user confidence in the tool and the decisions made therein.

5.2.2.5 Incorporation of Qualitative Criteria Quantifier

The Qualitative Criteria Quantifier module is accessible via a dedicated callout (Figure 5.4) that prompts users to 'Select Criteria', thereby engaging them in the process of creating a score for inherently qualitative criteria. The design of this callout is intentionally prominent, drawing the user's attention to the capability of the tool to encapsulate a comprehensive range of job attributes beyond the numeric, thus facilitating a holistic evaluation of potential job opportunities.

Upon interaction, the callout expands to offer a detailed view, wherein users are guided through the selection of non-numeric criteria. The 'Read More' option provides an avenue for users to delve deeper into the methodology behind the Qualitative Criteria Quantifier, ensuring transparency and enhancing their understanding of the tool's analytical framework.

The inclusion of this feature reflects the tool's effort to offer a more comprehensive approach to job ranking, recognizing the diverse preferences of job seekers. This feature is part of the tool's broader goal to create a user-friendly platform that simplifies complex decision-making, aiming to make the process more intuitive and informative.

5.2.3 Design of Profile Section

The Profile Section (Figure 5.6) will serve as a personalized dashboard for job seekers to add their job-seeking goals. It guides the user to state their job-seeking goal and will serve as a guiding aspect of the design. See 4.2.1.3.

5.2.4 Proposed Design

In the context of the design proposal, the design advocates for a user-centric interface that seamlessly synthesizes quantitative data and qualitative data into the job-seeking

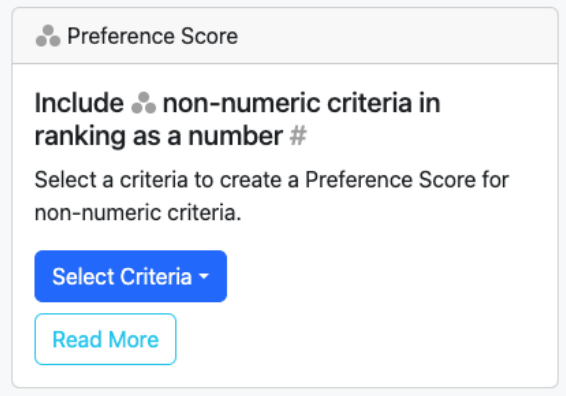

Figure 5.4: Design of the Qualitative Criteria Quantifier callout view.

experience. This approach (illustrated in Figure 5.7) is informed by a comprehensive understanding of user requirements, ensuring that the tool is accessible and adaptable to a wide demographic of job seekers. The proposed design upholds the complexity of user preferences, establishing a tailored experience that is both intuitive and inclusive. Subsequent sections will articulate the strategy for implementing this design, setting a precedent for developing a sophisticated job search platform that is fundamentally aligned with the nuanced needs of its users.

5.3 Implementation

The implementation of the tool represents a harmonious integration of several advanced web technologies, each chosen for its distinct capabilities that contribute to an effective job search platform.

5.3.0.1 LineUp.js Integration

LineUp.js library forms the foundational framework within the implementation architecture, excelling at rendering interactive, data-driven rankings. Its deployment strategically caters to the quantitative data processing required for job searching, providing robust sorting and filtering capabilities.

5.3.0.2 React Framework

The user interface is implemented using React, known for its declarative and component-based architecture. This choice ensures a modular and maintainable codebase, offering the flexibility necessary for creating a dynamic user experience. React's capacity for efficient

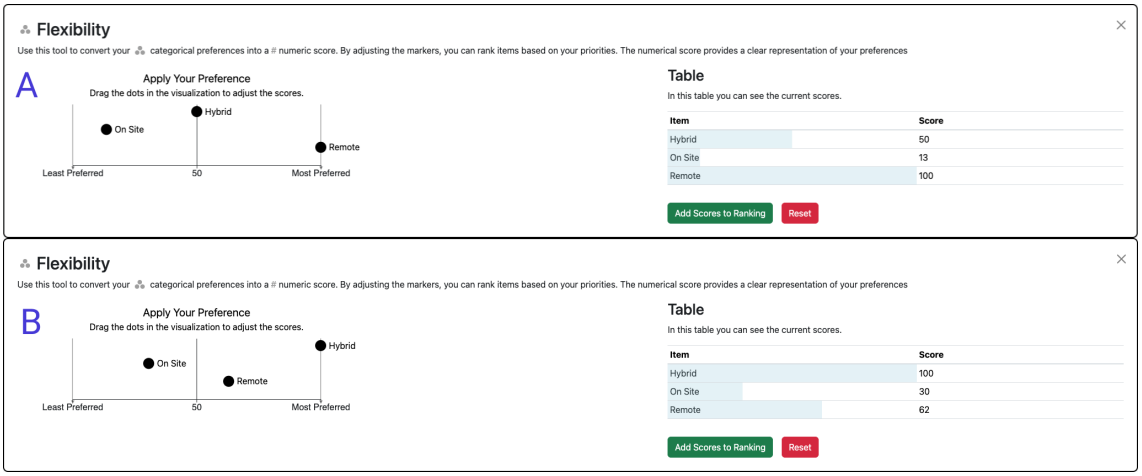

Figure 5.5: Qualitative Criteria Quantifier comparison in 2 scenarios. In scenario A the user looks for a remote job or possibly and hybrid while not looking for an On-Site job. In scenario B the user looks for and Hybrid job while being open to Remote work and not looking for On-Site options. This information is presented both in visualization and table.

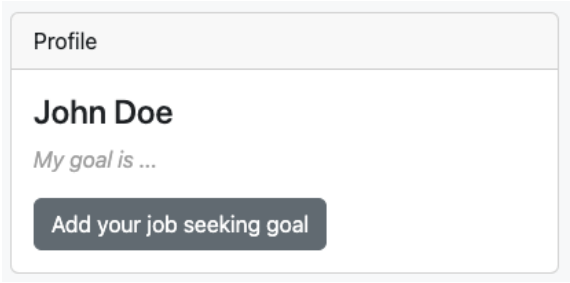

Figure 5.6: Profile Section interface.

state transitions and UI updates is particularly advantageous, where real-time interactivity is crucial to user engagement.

5.3.0.3 D3.js for Visualization

D3.js is integrated to enhance the platform's interactivity by enabling complex graphical elements. It is utilized for its powerful document manipulation based on data, essential for the visualization of qualitative criteria, and the customization of Qualitative Criteria Quantifier—functionalities that LineUp.js does not natively support.

5.3.0.4 Technological Synergy

The combination of LineUp.js, React, and D3.js is a strategic decision to harness each technology's strengths. These technologies were selected not only for their merits but also

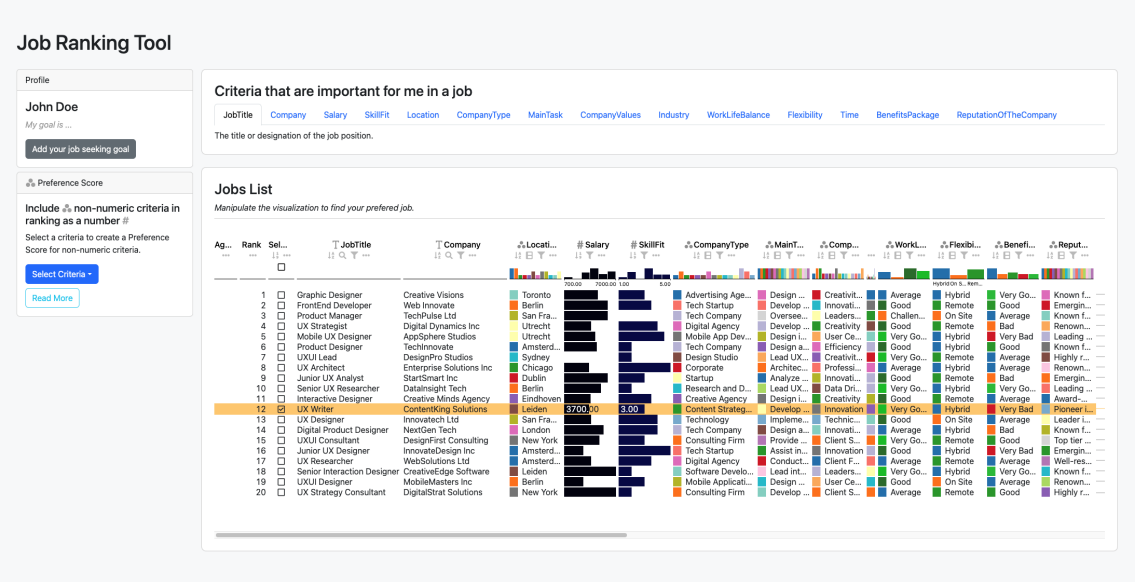

Figure 5.7: Tool overview.

for their collective potential in developing data-intensive applications. Their integration is aimed at delivering a platform that is technically robust and meets the diverse needs of job seekers.

The rationale behind this technological combination is to adhere to modern web development standards and ensure alignment with a user-centered design philosophy. The frameworks' widespread adoption, active community support, and extensive documentation significantly contribute to their selection, facilitating a state-of-the-art yet user-research-grounded tool. The whole tool can be found on Github (87).

5.4 Evaluation Methodology

In this section, the evaluation methodology is detailed, encompassing the various approaches and tools employed to assess the design's effectiveness. The process of implementing this evaluation, including the specific strategies utilized for data collection, is then elaborated. Additionally, this section addresses the ethical considerations inherent in conducting such research, ensuring adherence to academic and professional standards.

The primary objective of this evaluation was to assess the impact of newly implemented features, specifically the Profile section and Qualitative Criteria Quantifier, on users engaged in job-seeking activities. The evaluation was divided into 2 distinct phases, Phase

1 was Interview and Dataset creation, and Phase 2 was Usability Study followed by an interview.

5.4.1 Participant Selection

Participants were selected using the convenience sampling method and based on their active job-seeking status to ensure the relevance and applicability of the evaluation. In total seven participants joined the study. A group of young professionals from various backgrounds, including two university students and five young professionals aged 25-35.

All participants were provided with a consent form with detailed information about the interview, detailing the purpose of the study, and the nature of their involvement. They were given time to review this information and ask questions. Following this, informed consent was obtained from each participant before commencing the interview.

To ensure participant privacy, all personal identifiers were either removed or anonymized in the dataset. Anonymized transcripts were retained, and each participant was assigned a unique identification number for data analysis. All recordings are securely stored in the Yoda system, accessible exclusively to the researcher and supervisors. Furthermore, participants were guaranteed that any disseminated results would be thoroughly anonymized, maintaining individual confidentiality throughout the research process.

5.4.2 Phase 1 - Interviews and Dataset Creation

The objective of the initial interview phase was to develop a comprehensive understanding of the participants' job search criteria and preferences for specific types of positions. This understanding was crucial for creating a realistic dataset that would effectively simulate real-world job-seeking scenarios for subsequent phases of the evaluation. Participants were contacted using WhatsApp, where they also shared five unique links to job vacancies of their interest.

5.4.2.1 Overview of the Interview Process

The interview commenced with an open discussion about the participant's job-seeking criteria following a semi-structured format (88) (see Appendix C). This discussion started with broader topics, such as the preferred industry and company size, gradually narrowing down to more specific aspects, such as desired job roles and tasks, company culture, and work-life balance considerations. This approach was used to establish a spectrum of criteria that participants used to evaluate job opportunities.

Following this broad discussion, the conversation shifted to specific job listings that the participants had previously shared with the researchers. Participants were prompted to articulate the main factors of each job listing - the key reasons why they were attracted to these particular opportunities. The goal was to discern any discrepancies or alignments between the participants' stated criteria and the attributes of the jobs they were actively considering. Additionally, the participants revealed more criteria that were important to them.

5.4.2.2 Data Collection and Analysis

During the interviews, the researcher diligently noted down participants' responses, carefully capturing both the explicit criteria they mentioned and any implicit preferences inferred from their discussions about specific job listings.

5.4.2.3 Dataset Creation process

The dataset creation process was a critical step in ensuring the realism and relevance of the job-seeking simulation. It involved a comprehensive approach where both job listings provided by participants and job criteria extracted during the interview phase were combined. This combination of direct inputs and derived insights was utilized to create a detailed user persona for each participant. By tailoring each dataset to the individual preferences and criteria of each participant, the evaluation phase aimed to provide a realistic and engaging job-seeking experience, enhancing the relevance and applicability of the findings.

Below is a step-by-step explanation of the dataset creation process.

1. Understanding the Criteria The first step involved extracting the importance of criteria from participants' interviews to create a persona reflecting participants' preferences for a job. This persona was pivotal in guiding the dataset creation, ensuring alignment with their job search criteria and aspirations.

2. Initial Dataset Population In this step, the dataset was initially populated with the five job listings shared by the participants and filled in as items (rows), and 14 attributes (columns) were created. Subsequently, attribute values specific to each of the five job listings were created, reflecting the participants' preferences and the criteria established in the first step.

3. Initial Dataset Analysis An in-depth analysis of the initial dataset ensured it accurately reflected participants' specific information and preferences. This analysis was crucial to validate the relevance of the dataset to ensure a real-world job-seeking experience.

4. Creation of Hypothetical Listings In this step, 15 additional hypothetical job listings were created, each one derived from the initial dataset and specifically tailored to match the participants' interests. These listings comprised roles that were closely aligned with the participants' expressed job preferences. The feature on LinkedIn for finding similar jobs played a key role in identifying these roles, guaranteeing a close alignment with the participants' areas of interest. To further diversify the dataset, three out of the 15 listings were selected even though they did not directly align with the participants' stated interests, thereby introducing a wider variety of options. This strategy was adopted to ensure the dataset provided a comprehensive and realistic spectrum of potential job opportunities.

5. Ensuring Variety and Relevance To mirror the diversity in the field of interest and the preferences of the participants, the job listings were varied in terms of job titles, company types, and other attributes.

6. Review for Consistency Following the creation of these listings, a thorough review was conducted. This review ensured that each listing was consistent with the participants' persona.

7. Final Compilation The final step involved compiling the various hypothetical job listings into a comprehensive dataset. This dataset, tailored to each participant, was intended to provide a realistic and practical resource for evaluating the effectiveness of the designed tool in Phase 2. It offered a wide range of job options, reflecting the complexity and variety typical in the job-seeking process.

The dataset created in this phase will be used as input for the Phase 2 usability test to increase the realism of the study.

5.4.3 Results of Phase 1

The semi-structured interviews conducted in Phase 1 of the study offered insights into the job-seeking criteria and preferences of the participants. These interviews were instrumental in forming the dataset suitable for the tool and a real representation of participants'

preferences for vacancies. An example of the single job format can be found in Appendix E.

5.4.3.1 Key findings from Phase 1 interviews

The interviews revealed a range of insights critical for understanding the job-seeking process. A common thread across participants was the emphasis on various criteria for job selection, including salary, skill fit, location, growth opportunities, work-life balance, and the nature of the tasks involved in the job. This consistency underscores the universal importance of these factors in job-seeking.

However, there was noticeable variability in the importance assigned to each criterion, with participants emphasizing different aspects they prioritize first in a job listing. For example, the concept of 'Skillfit' emerged as a significant factor, where participants highlighted the need for their professional skills to match job requirements. This was often quantified similarly to LinkedIn's system, translating skill alignment into a percentage score.

Interestingly, participants expressed salary and skill fit as the only quantifiable criteria, distinguishing them from more qualitative factors. This distinction between qualitative and quantitative criteria sheds light on the different ways job seekers evaluate potential roles.

Additionally, reactions to job listings were influenced by unique personal factors, where often a singular reason made certain listings stand out, despite these meeting their broader criteria. This points to the role of personal alignment and individual 'X-factors' in job selection, emphasizing how participants prioritize listings that closely resonate with their career aspirations and personal values.

5.4.3.2 Key findings from Phase 1 Dataset creation

The dataset creation process in Phase 1 was informed significantly by the interviews conducted. Despite the diversity in participant backgrounds and job aspirations, a commonality in job selection criteria emerged. This similarity allowed for the creation of a standardized job criteria (attribute) list, which was then used to tailor individual datasets for each participant. The criteria list, comprehensive and reflective of the various aspects important to job seekers, ensured that each dataset was personalized while maintaining a consistent structure across all participants. The following criteria were included in every

dataset, with inputs specifically tailored to align with each participant's unique preferences and requirements. The criteria list can be seen in Table 5.1

Criteria	**Description**
Job Title	The title or designation of the job position.
Company	The name of the company or organization offering the position.
Salary	The gross monthly salary for the job in euros or dollars depending on the location.
Skill Fit	A numerical representation (1 to 5) indicating how well an individual's skills align with the job requirements.
Location	The city or region where the job is located.
Company Type	The type or category of the company, such as 'Pharmaceutical' or 'Biotechnology'.
Main Task	The primary responsibilities and tasks expected to be performed in the role.
Company Values	The core principles or ethos that the company upholds and promotes.
Industry	The sector or field in which the company operates.
Work-Life Balance	An assessment of the balance between work and personal time that the role allows.
Flexibility	Information on the flexibility of the job's working conditions, such as 'On Site', 'Hybrid' or 'Remote'.
Time	The type of employment in terms of time commitment, e.g., 'Full-time' or 'Part-time'.
Benefits Package	A brief summary of the additional perks or advantages provided by the company aside from the salary.
Reputation of the Company	A description or statement about the company's standing or achievements in its industry.

Table 5.1: Job Criteria and Their Descriptions

This structured approach to dataset creation was pivotal in ensuring that the datasets accurately reflected the diverse yet consistent job-seeking preferences and requirements of the study's participants.

5.4.4 Phase 2 - Usability Testing

Phase 2 of the study involved usability testing, consisting of four distinct tasks, followed by a post-test interview. The usability test was designed to observe how users interact with the tool, with the dataset created in Phase 1 inserted into the tool for each participant.

The study was structured in the following steps:

1. **Introduction to the Study:** Participants were given an overview of the study, outlining its objectives and what their participation would entail. This introduction served to orient the participants and set expectations for the usability test.

2. **Training on LineUp:** Before commencing the usability test, participants received training on LineUp's basic functions. This training was conducted on Forbes Top 2000 dataset, independent from the job ranking tool. Where the researcher demonstrated how to perform essential tasks such as sorting, filtering, grouping, and calculating a weighted average. The purpose of this training was to ensure that participants were comfortable with the basic functionality of LineUp and could effectively use it during the test.

3. **Usability Study with four Tasks:** The main component of Phase 2, where participants engaged in a series of tasks designed to test the tool's usability.

4. **Post-Study Interview:** A discussion with participants following the usability test to gather feedback and additional insights into their experience with the tool.

5. **Demographic Questionnaire:** Participants were asked to complete a questionnaire to collect demographic information such as age, gender, and career status.

5.4.4.1 Usability study

Usability testing was structured around four distinct tasks, each tailored to evaluate specific functionalities of the tool and their alignment with user needs and behaviors. The usability study was conducted as a think-aloud session (89). During the think-aloud session, the user was encouraged to verbalize their thought processes and decision-making strategies while engaging in the job search tasks. The tasks were designed to capture participant interactions and thought processes, providing insights into how the tool was used and perceived.

The four distinct tasks in the usability study were designed to assess different aspects of the tool's functionality and its alignment with the participants' needs and behaviors in a job search context.

1. **Task 1: Input your Job-Seeking Goal** This task aimed to understand how participants define and articulate their job-seeking goals using the tool. It assessed the tool's ability to capture and reflect individual job search objectives, a key aspect of personalizing the job-seeking experience.

2. **Task 2: Evaluate/Rank the jobs based on your preference. Establish the most and least preferred job.** In this task, the primary goal was to evaluate the tool's effectiveness in helping participants prioritize job listings based on their personal preferences, before using the Qualitative Criteria Quantifier function. Participants were guided to use the dataset presented to them, assessing and ranking jobs according to their individual preferences to identify the most and least preferred jobs. During this process, participants were not restricted from using other features of the tool, providing a comprehensive view of how well the tool supports users in making comparative evaluations and informed decisions in a user-centric environment.

3. **Task 3: Turn non-numeric data into numerical data** This task involved participants using the Qualitative Criteria Quantifier feature to convert categorical job data into quantifiable scores. The aim was to test the tool's capability to handle and convert qualitative or categorical data into a quantifiable format. It was crucial to understand how participants interact with and perceive the Qualitative Criteria Quantifier part of the tool.

4. **Task 4: Evaluate/Rank the jobs based on your preference. Establish the most and least preferred job.** After completing the Qualitative Criteria Quantifier task, participants were asked to perform the job ranking process again. This task was designed to observe how the insights gained from the Qualitative Criteria Quantifier influenced their subsequent job rankings. The aim was to observe how the participants' job ranking choices changed after using the Qualitative Criteria Quantifier feature. This task provided insights into the tool's impact on the participants' decision-making process, particularly how quantifying preferences influences their job evaluation and selection.

The researcher encouraged participants to verbalize their thought process, thereby facilitating a deeper understanding of their interaction with the tool and its impact on their job-seeking experience.

5.4.4.2 Post-Study Interview

The protocol for the post-study interview, designed to collect qualitative feedback on the tool's usability, is thoroughly detailed in Appendix D. This approach prioritized qualitative observations derived from the participants' responses, focusing on their direct experiences and perceptions of the tool.

The interview questions, as listed in Appendix D, were structured to elicit insights in the following areas:

- **Intuitiveness and Clarity:** Questions such as "Were there parts of the tool that felt intuitive?" and "What aspects were confusing or unclear?" were designed to gauge the tool's intuitiveness and user-friendliness. This helped in understanding how easily participants could navigate and utilize the tool without prior instruction.
- **Perception of Mechanisms:** The question "How do you feel about the preference scoring mechanism?" aimed to gather participants' thoughts on specific features of the tool, particularly how they perceived and interacted with the preference scoring system.
- **Impact on Decision-Making:** The final question, "How do you feel about your choices before and after using the preference score?" was intended to assess the tool's influence on the participants' decision-making process. This focused on understanding whether the tool impacted their choices and confidence in making decisions based on the provided preference scores.

This approach, centered around specific, open-ended questions, provided valuable qualitative insights into the participants' experiences. It allowed for an in-depth understanding of how the tool was perceived.

5.4.4.3 Data Collection and Data Analysis

This section outlines the methodologies employed in both the collection and analysis of data for the usability study. The study was designed to gather comprehensive insights into the user experience of the usability of the tool, with a focus on the Qualitative Criteria Quantifier mechanism.

Data Collection Method The usability study was conducted in a well-prepared environment to ensure consistency and effectiveness. Each session took place in a quiet room, equipped with a computer setup that included a monitor of at least 19 inches, a standard computer mouse, and a keyboard. This specific setup was chosen to maintain a consistent testing environment across all participants, thereby increasing the reliability of the usability test results.

During the usability sessions, special attention was given to capturing the participants' verbal feedback. For that purpose, the session was recorded using an audio recorder.

This approach was crucial for capturing their immediate reactions, thoughts, and verbal expressions as they interacted with the tool. The focus on verbal feedback provided a direct insight into the participants' experience, enhancing the depth and quality of the data collected.

Data Analysis Approach The primary method employed for this analysis was open coding, a qualitative technique particularly suited to interpreting complex user interactions and feedback (90). This process involved several stages, from the preparation of interview transcripts to the final interpretation of categorized data. The open coding method was chosen for its flexibility and effectiveness in identifying key themes and patterns in qualitative data, allowing for a nuanced understanding of user experiences and perceptions.

The coding process was done in the following steps:

1. **Preparation of Usability Study Data:**

   Transcripts of the usability study and post-study interview were prepared.

2. **Initial Reading and Familiarization:** The transcripts were read thoroughly to gain an initial understanding of the participants' perspectives and responses.

3. **Identification of Preliminary Codes:**

   During a detailed review of the transcripts, key phrases, concepts, and recurring themes related to the usability of the tool were identified and labeled as initial codes. Examples of some of the initial codes:

   - **Ease of Use:** Comments about the overall ease or difficulty of using the tool. Example quote:

     "I think it's really good... And it like made things way easier." Participants comment about the Qualitative Criteria Quantifier mechanism.

   - **Feedback on Visual Design:** Observations or opinions about the visual design and aesthetic appeal of the tool. Example quote:

     "The grey wasn't eye-catching."

   - **Decision Making Efficiency:** Remarks on how the tool affected participants' decisions. Example quote:

     "Basically gave me the same results I had already found but in a way quicker way."

- **Qualitative Criteria Quantifier Mechanism Feedback:** General expressions of satisfaction or dissatisfaction with the Qualitative Criteria Quantifier mechanism. Example quote:

  "I think it was good because it's nice that you can put a score to things ... "

- **Tool Intuitiveness:** References to the time and effort required to become proficient in using the tool. Example quote:

  "Yes like all the sorting and filtering and especially because of the animations they make it very feel very natural."

- **Feature Suggestion & Interactive AI Integration:** Feedback on the additional functionality for the tool. Example quote:

  "Would also be cool if you could add in a ChatGPT feature."

- **Reflection on Decision-Making:** Insight the participants gained about their decision-making process from using the tool. Example quote:

  "I'm not as open-minded as I thought I was."

4. **Refinement and Organization of Codes:**

   The initial codes were compared, refined, and organized. This step involved merging similar codes and eliminating redundant ones.

5. **Development of Themes:**

   The refined codes were then grouped into broader themes that represent the overarching themes or concepts emerging from the data.

   - Qualitative User Feedback
   - Impact on Decision-Making Process
   - Feature
   - Qualitative Criteria Quantifier Usability
   - Score Reflection
   - Emotional and Personal Responses
   - Guidance

6. **Interpretations:**

   Finally, the themes and their meanings were interpreted in the context of the overall study.

This coding process enabled a comprehensive analysis of the qualitative data from the usability test and interviews, providing depth and context to the findings of the usability test.

5.4.5 Results of Phase 2

This section elucidates the findings of the Usability study, primarily focused on evaluating the design of the job-seeking tool and its effectiveness in aiding job seekers. Phase 2 comprised usability testing, utilizing the think-aloud method, to assess the tool's practical application and interviews to understand participants' experience with the tool. Phase 1 and Phase 2 of the study had the same 7 participants.

5.4.5.1 Qualitative Criteria Quantifier Usability

Participants interacted with the Qualitative Criteria Quantifier feature, which required them to translate qualitative preferences—like work environment options (Hybrid, On Site, Remote)—into quantifiable scores. This conversion was facilitated through a draggable interface where participants adjusted markers along a slider to reflect their preference intensity.

The scoring view comprised two primary components:

- **Adjusting the Markers:** Participants clicked and dragged the markers on the slider, often pausing to contemplate the relative importance of each item in the criteria before committing to a position on the scale. Adjusting the marker was not intuitive for all the participants. Three participants reported that they had to read through the instructions to use it.

- **Verbal Feedback:** As they interacted with the tool, many users verbalized their thought process, such as "Hybrid offers flexibility, so I'll score this higher" or "I prefer not to work remotely, so I'll place this lower."

- **Score Reflection:** Upon adjusting the sliders, users looked to the scoring table for confirmation, remarking on the numeric representation of their preferences. Comments such as *"This number feels right for ..."* were common.

- **Iteration and Refinement:** Several participants iteratively adjusted the markers, refining their scores as they further reflected on their preferences. This behavior indicated a level of engagement and a desire to accurately capture their job-seeking priorities.

Participants' interactions with the tool were observed to identify patterns in how they approached the task of scoring. Some users were seen to rapidly assign scores, relying on their initial instinctual responses to each criterion. In contrast, others took a more deliberate approach, making finer adjustments and frequently referring to the scoring table for precise feedback. P4 feedback on the score table was following *"... the fact that I move it here and then I see suddenly in the table like what happens. That's very nice."*

Figure 5.2 showcases the interface design. Observations during the interaction sessions noted that users appreciated the visual and interactive elements, suggesting a high level of engagement with the tool. However, some participants reported a poor understanding of the score integration into the ranking, *"This non-numeric criteria, is that already going to be integrated?"*. Participants recommended the additional feature to clarify the implications of their scoring decisions for the final job rankings.

Feedback collected during post-interaction interviews provided insights into user satisfaction with the scoring mechanism and its perceived ease of use. Participants suggested that while the tool was effective in capturing their preferences, additional guidance or examples of how scores would influence job rankings could enhance the user experience.

Qualitative User Feedback

Post-interaction interviews provided deeper insights into the users' experiences:

- **Intuitiveness:** A portion of users found the visual elements of the scoring interface to be intuitive, aiding in the translation of their preferences into scores. P7 reported *"So to be able to do it really quickly and it's really intuitive that just dragging the dots I thought was a really nice."*

- **Learning Curve:** Users showed different levels of proficiency in the use of the tool. Some users needed more time to figure out how to effectively utilize the scoring system.

- **Confidence in Decision-Making:** There was a consensus among users that their final job rankings felt more aligned with their personal preferences after using the

scoring system, thus increasing their confidence in decision-making with the help of more data. P2 said *"It makes you feel more confident that you made the right decision because it feels like the data shows, what you are looking for."*.

5.4.5.2 Impact on Decision-Making Process

The effectiveness of the Qualitative Criteria Quantifier feature was evaluated based on its impact on the job decision-making process. The primary measure was the participants' qualitative reporting on their confidence and satisfaction with their job selection before and after using the feature.

Satisfaction with Job Rankings

The majority of participants expressed satisfaction with how the Qualitative Criteria Quantifier system allowed for a personalized and nuanced approach to job ranking. They reported that the tool successfully captured and displayed the relative importance of diverse job aspects, as illustrated in the visual output of the scoring system.

Enhanced Decision Confidence

A notable outcome was the reported increase in users' confidence in their job selections. The quantification of qualitative job attributes appeared to provide users with a clearer rationale for their choices, thereby reinforcing their decision-making process.

5.4.5.3 Recommendations for Tool Enhancement

The study's findings have prompted several recommendations for improving the tool, focusing on personalization to enhance user experience:

- **Resume Storage and Integration:** Incorporate a feature that allows users to upload and store their resumes within the tool. This would enable the tool to tailor job suggestions more accurately based on the user's professional background and skills.
- **Customized Job Matching:** Enhance the tool to establish direct links between stored resumes and job listings. This would allow the tool to automatically suggest job opportunities that align closely with the user's experience and qualifications, streamlining the job search process.

These proposed enhancements aim to make the tool more user-centric, offering a tailored experience that resonates with individual job seekers' needs and career aspirations.

6

Discussion

6.1 Interpretation of Findings

The development and evaluation of the novel visualization tool in this study have provided significant insights into job-seeking behavior and decision-making processes. The usability study and qualitative user feedback collected indicate that the tool effectively meets the identified needs of job seekers, enhancing their experience and decision-making capabilities. The customized design of the tool, using the combination of LineUp (5) and Qualitative Criteria Quantifier functionality, resulted in high job ranking satisfaction and decision confidence among users as reported in Section 5.4.5.2. This suggests a positive impact on the job-seeking process, aligning well with the objectives of proposing and evaluating a novel visualization prototype tailored for job seekers.

6.2 Contextualizing with Literature

In comparison to general-purpose Multi-Criteria Decision Making (MCDM) tools like WeightLifter (10), Zooids (4), and Podium (9), this thesis presents a more specialized and domain-specific solution tailored for the job-seeking process, underscoring the adaptability and effectiveness of MCDM methods in addressing nuanced and complex decision-making scenarios, as also evidenced by studies like the fuzzy inference system for job evaluation using fuzzy AHP (91). The approach in this thesis integrates the Qualitative Criteria Quantifiersystem with LineUp (5), a visual analysis tool for multi-attribute ranking, adept at addressing the unique complexities and subjective elements inherent in job-seeking (15). A key feature of this integration is its ability to transform qualitative criteria into quantifiable numbers, effectively bridging subjective and objective aspects of job-seeking. Adding

to this domain-specific focus is the study's strength in using a tailored, realistic dataset for usability studies. The dataset creation process was meticulously designed to align with the specific job listings relevant to each participant, ensuring that the dataset used in each participant's usability study was representative of their unique job-seeking preferences and reflective of real-world scenarios. By utilizing the Qualitative Criteria Quantifier system to effectively handle the intricacies of job seekers' data, this approach significantly advances the usability and relevance of MCDM tools in the job-seeking domain.

Moreover, the discussion in this thesis extends to the strategic implementation of Attribute Scoring Functions (ASF) (referred to as Qualitative Criteria Quantifier system in this research), as explored in (85) and implemented in RankASco (86), highlighting how ASF can be adapted for multi-attribute ranking tools to offer more personalized and context-specific solutions. Such customization, particularly through the Qualitative Criteria Quantifier system, plays a crucial role in the study. This tailored implementation of the Qualitative Criteria Quantifier was evaluated using a personalized dataset. This personalized approach enabled more accurate and detailed analysis of the Qualitative Criteria Quantifier feature's impact, providing deeper insights into the tool's performance in a realistic decision-making context. The study's ability to assess the tool's effectiveness and identify its strengths and weaknesses in practical settings showcases the significant potential of ASF in enhancing job-seeking experiences.

6.3 Implications

The implications of this study are multifaceted. On a practical level, the tool provides a more user-friendly and efficient way for job seekers to navigate the job list and through that increase the general job-seeking experience (21). Theoretically, this study contributes to the literature on MCDM and HCI by demonstrating the effective integration of ASF's (85) visualization into MCDM visualization tool (5). Methodologically, it underscores the importance of user-centered design in developing practical decision-making tools for specific domains.

6.4 Limitations

While the study showcases several strengths, it also presents limitations that highlight areas for future exploration and improvement.

A primary limitation of the current study is its reliance on qualitative feedback to assess usability. While this approach provides valuable insights, it lacks quantifiable measures that can more precisely gauge the tool's effectiveness. To address this gap, future studies should incorporate quantitative methods in usability evaluation. This shift towards quantifiable metrics would allow for a more objective assessment of the tool's performance. Additionally, expanding the research scope to include various stages of the job-seeking process, such as initial job searches, application submissions, and post-application follow-ups, is essential. Such a comprehensive approach would provide a more complete understanding of the tool's effectiveness across the entire job-seeking journey, offering a balanced view that combines both qualitative impressions and quantitative performance data.

Another area for enhancement is the diversity of the study's participants. Future research should aim to broaden the participant demographic to assess the tool's applicability across different job sectors and user backgrounds. This expansion is vital as it would shed light on the tool's versatility and adaptability in diverse contexts (27). Different job sectors have unique criteria and challenges that might influence the tool's performance and user experience. Similarly, understanding how the tool functions across a wide range of user backgrounds is essential to ensure its effectiveness and accessibility to all job seekers.

Additionally, conducting a longitudinal study could provide invaluable insights into the long-term interaction of users with the tool. Such an approach would allow researchers to observe patterns in tool usage over time, how user preferences evolve, and the eventual outcomes in terms of job placements (22). A longitudinal perspective is critical in assessing the tool's sustained efficacy and its broader impact on the job-seeking process.

Lastly, the potential for selection bias, stemming from the voluntary nature of participant involvement, is a notable concern. Participants who opt to join such studies might possess specific interests in technology or job-seeking, potentially skewing the study results and not accurately representing the general population. Recognizing and addressing this potential bias is crucial for enhancing the validity and generalizability of the study's findings.

Addressing these limitations in future research will not only strengthen the tool's development but also ensure its relevance and applicability to a broader audience, thereby making significant strides in the field of job-seeking tools and methodologies.

6.5 Future Research

Future research should continue to advance upon the findings of this study, focusing on several key areas to enhance the effectiveness and usability of MCDM tools in job-seeking.

A critical step forward involves the development of a specialized job-seeking tool that intricately combines a specific Multi-Criteria Decision Making (MCDM) method with Attribute Scoring Functions (ASF). This endeavor would entail selecting and implementing a distinct MCDM technique, such as the Analytic Hierarchy Process (AHP), Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS), or VIKOR. The integration of these techniques with ASF aims to increase decision-making accuracy and efficiency, creating a tool that not only benefits from the structured framework of MCDM methods but also embraces the nuanced evaluation capabilities of ASF in assessing various job opportunities and criteria.

In parallel to the technical development of these tools, it is essential to explore how different user contexts and life situations influence interactions and outcomes with MCDM job-seeking tools. Future studies should delve into understanding the effects of factors like career stage, employment status, and geographical location on user preferences and decision-making processes. Gaining a comprehensive understanding of these contextual variables is imperative, as it can inform the development of more adaptable and user-sensitive features within these tools, ensuring that they meet the diverse needs of job seekers.

Furthermore, future research should prioritize explorative studies that delve into a variety of methods for integrating qualitative criteria into MCDM tool rankings, with a specific focus on different Attribute Scoring Functions (ASF) techniques, such as those outlined in (85). This exploration is crucial to discern how different approaches, including both equidistant and non-equidistant techniques, impact the tool's effectiveness in the job-seeking process. These studies should extend beyond competitive analyses and thoroughly investigate a range of techniques and features. This includes interactive user interfaces for easy input and modification of qualitative preferences, as well as various data visualization methods that effectively represent qualitative data alongside quantitative metrics. Additionally, exploring computational method like fuzzy logic, which can be instrumental in quantifying and integrating qualitative criteria into the ranking process. By examining the diverse applications of ASF techniques, future research can significantly enhance the ability of MCDM tools to incorporate and balance personal preferences, company culture, and work-life balance considerations, thereby improving their overall effectiveness in the job-seeking process.

The overarching goal of these comparative analyses is to identify and refine methods that seamlessly blend qualitative and quantitative information within MCDM tools. Achieving this blend is crucial for crafting a holistic and user-centered tool that accurately mirrors

the complex nature of job-seeking decisions. Understanding the nuances and impacts of these qualitative integration methods promises to drive substantial improvements in user experience and decision-making efficiency, thereby significantly advancing the field of job-seeking tools.

7

Conclusion

In conclusion, this thesis presents an innovative job ranking tool tailored to job seekers' needs. Initial research, including interviews, revealed job-seekers' preference for qualitative criteria, not adequately addressed by existing Multi-Criteria Decision Making tools. This gap led to the development of a modified LineUp.js tool, integrating a Qualitative Criteria Quantifier inspired by Attribute Scoring Functions, enabling users to score qualitative criteria. This tool facilitated a more personalized, structured job-seeking experience, as discovered by usability testing. The tool not only meets job seekers' specific preferences but also demonstrates the applicability of augmented Multi-Criteria Decision Making (MCDM) tools in job seeking. These findings enrich the fields of MCDM and Human-Computer Interaction, paving the way for future research into applying MCDM in the job-seeking domain.

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Appendix

Appendix A

Interview Protocol

Introduction

1. Introduce yourself and the purpose of the study.
2. Explain the format, duration, and recording method of the interview.
3. Provide information on the confidentiality of the participant's responses.
4. Obtain informed consent.

Warm-up Questions

1. Can you please tell me a little about your background and job search experience?
2. How long have you been actively searching for a job (if applicable)?
3. What are your career goals?

Critical Incident Technique

Research Question 1: Key qualitative criteria

1. Can you recall a specific job opportunity you considered recently? Please describe it.
2. What were the main factors you took into account when evaluating this job opportunity?
3. Were there any qualitative criteria that stood out as particularly important to you? Please explain.
4. How did you prioritize these factors in your decision-making process?

Research Question 2: Guidance and support

1. Think of a time when you felt lost during your job search. Can you describe the situation?
2. What resources, tools, or support did you use to address the challenges you faced in that situation?
3. What type of guidance or support was most helpful to you during that experience?
4. Imagine that you would have a tool that could do anything. Please describe it.

Research Question 3: Prototype development and improvement

1. Could you please draw or visualize the decision process? (Give pen and paper)
2. Could you please draw what the tool that could do anything would look like? (Give pen and paper)
3.

Closing Questions

1. Is there anything else you would like to share about your job search experience or expectations from a job search tool?
2. Do you have any questions for me about the study or the interview process?

Appendix B

Questionnaire

1. Age: Request the age range or specific age of the participant to analyze the responses across different age groups.
2. Gender: Ask the participant's gender to examine any potential differences in job search experiences between genders.
3. Education level: Inquire about the highest level of education completed (e.g., high school, bachelor's degree, master's degree, Ph.D.) to explore the relationship between educational background and job search experiences.
4. Field of study: Determine the participant's field of study or major to understand the potential differences in job search experiences across various disciplines.
5. Employment status: Collect information about the participant's current employment status (e.g., employed, unemployed, underemployed, student) to assess the urgency and priorities in their job search.
6. Years of work experience: Request the number of years of work experience the participant has, which can help analyze the responses in relation to their professional experience.
7. Industry: Determine the industry in which the participant is currently working or seeking employment to explore differences in job search experiences across various industries.
8. Geographic location: Inquire about the participant's current location, as job search experiences and requirements may vary depending on the local job market.

9. Job search frequency: Determine how frequently the participant engages in job searches (e.g., first-time job seeker, occasional job seeker, active job seeker) to analyze the responses in relation to their job search habits.

Appendix C

Phase 1 - Interview protocol

Introduction

1. Introduce yourself and the purpose of the study.
2. Explain the format, duration, and recording method of the interview.
3. Provide information on the confidentiality of the participant's responses.
4. Obtain informed consent.

Semi-structured interview

General job-seeking criteria

1. What are the factors or aspects you consider when looking for a job?
2. Can you share in more detail why this factor is important for you?
3. How did you prioritize these factors in your decision-making process?

Specifics of the shared job listings

1. What were the main factors you took into account when evaluating this job opportunity?

Closing Questions

1. Is there anything else you would like to share?
2. Do you have any questions for me about the study or the interview process?

Closing Statements

1. Agree on the Phase 2 time.

2. Thank the participant for the interview.

Appendix D

Phase 2 - Interview protocol

Introduction

1. Introduce yourself and the purpose of the study.
2. Explain the format, duration, and recording method.
3. Provide information on the confidentiality of the participant's responses.
4. Obtain informed consent.

Post Usability test interview

1. Were there parts of the tool that felt intuitive?
2. What aspects were confusing or unclear?
3. How do you feel about the preference scoring mechanism?
4. Do you feel about your choices before and after using the preference score?

Closing Questions

1. Is there anything else you would like to add about the tool?
2. Do you have any questions for me about the study?

Closing Statements

1. Thank the participant for participating in the study.

Appendix E

Example data

Dataset was in JSON format "JobTitle": "UX Designer", "Company": "Innovatech Ltd", "Location": "San Francisco", "Salary": 4000, "SkillFit": 4, "CompanyType": "Technology", "MainTask": "Implement UX designs into functioning code", "CompanyValues": "Technical Excellence", "Industry": "Software Development", "WorkLifeBalance": "Good", "Flexibility": "On Site", "BenefitsPackage": "Average", "ReputationOfTheCompany": "Leader in innovative software solutions"