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Digital Skill Matrix for Manpower Planning

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Abstract

In the dynamic landscape of workforce management in industries, traditional skill assessment and manpower planning methods have proven to be inadequate and ineffective, leading to suboptimal resource allocation, skill gaps, and reduced productivity. This paper introduces a comprehensive solution aimed at addressing these challenges. The project will build a robust system that utilizes real-time data analysis and Search algorithms to search and quantify the skills of individual operators. By seamlessly integrating data from various stations in an assembly line, encompassing crucial parameters such as operator ID, part barcode, station identity, cycle time, and the frequency of reworks, retrieved from a MySQL database, the digital skill matrix is developed.

Keywords: SQL • Python • Digital skill matrix • Significant skill gaps

Introduction

Traditional methods for skill assessment and workforce management typically involve manual processes such as resume and interview evaluations, on-the-job training, certifications, and supervisor assessments. These methods can be subjective, time-consuming, and may not provide a comprehensive view of an individual's skills. In today's rapidly evolving industrial landscape, the traditional methods of skill assessment and workforce planning have proven to be inadequate and outdated. This inadequacy often leads to a misallocation of resources, significant skill gaps, and a consequential decrease in overall productivity. This paper introduces a solution aimed at transforming how organizations approach skill evaluation and resource allocation, ultimately addressing these pressing challenges.

The core of this solution is a system that leverages real time data analysis and a data driven evaluation algorithm. It seamlessly analyses data from stations in an assembly line using a MySQL database. The applications of the Digital skill matrix are vast and impactful as they provide benefits, across industries. Whether its manufacturing or assembly operations or any other sector organizations can gain an advantage by measuring and evaluating operator skills in real time. This method allows for the allocation of resources reduces any gaps in skills and improves productivity, having an overall impact on managing the workforce.

Literature Review

Existing system

The rapidly evolving concept of the digital skills matrix holds particular promise in personnel management and skills assessment. An analysis conducted at Siemens Ltd. Nashik sheds light on the importance of skill matrices in comprehending the skill levels of employees within an organization. The study emphasizes the need for a set of tools to assess training needs and address existing skills gaps in the workforce [1].

The absence of a specific skill metric system in the Ready-Made Garment (RMG) industry in Bangladesh has led to miscommunication and technical confusion in this context, research highlights the importance of skill mapping to identify labor areas mature and skilled. The study examines how a competency metric evaluation system has been developed for the RMG sector, which not only reduces miscommunication but also aims to reduce workplace violence. The proposed system that introduces QR code scanning and a more transparent assessment process could transform competency assessment and personnel management in this industry [2].

The concept of critical competency mapping is important not only for understanding employee capabilities but also for evaluating the perception of employees in an organization A survey conducted

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among employees of Harita-NTI Ltd in Chennai shows how competency mapping can visualize the image of the employee in the minds of employees. By analyzing employee skills, abilities, and attitudes, this approach can help streamline the training process and improve employee management [3].

Known for its simplicity and extensive standards library, Python is emerging as the preferred platform for working with databases and SQL. A scientific article goes into detail on using Python with database systems including Oracle, MySQL, Microsoft SQL Server, PostgreSQL, and SQLite. Python's cross-platform compatibility and ease of use make it an attractive choice for developing database applications. Python simplifies database operations by providing a broad range of tools and features, making it an attractive choice for developers involved in database operations, however, potential performance limitations and the need for database- specific features are important to consider when choosing Python in database applications. In summary, the concept of digital skills metrics is gaining popularity in personnel management, and skills assessment is becoming increasingly important in today's rapidly changing business environment. Python acts as a versatile platform for database and SQL applications, offering flexibility and a great ecosystem, although performance limitations and database-specific considerations should be considered when choosing this option [4].

In summary, the concept of the digital skill matrix is gaining prominence in workforce management, and skill assessment is increasingly critical in today's rapidly changing work landscape. The absence of specific skill matrix systems in certain industries, such as the RMG sector in Bangladesh, highlights the need for innovative solutions. Python serves as a versatile platform for database and SQL operations, offering simplicity and a vast ecosystem, although performance limitations and database-specific considerations must be considered when choosing this approach. By amalgamating these insights, the project aims to bring innovation to workforce management and skill assessment, particularly in industries facing challenges related to skill gaps and skill tracking [5].

Proposed system

The employee survey evaluation framework outlined in this approach is designed to provide a comprehensive approach to measure and evaluate employee performance in a manufacturing plant. All of these systems are a combination of components, ensuring an efficient assessment process. Initially, a comprehensive needs assessment is conducted to clearly understand the specific needs and objectives of the production facility. This important section outlines key performance metrics, expected results, and overall objectives of the evaluation. By defining these requirements, the process lays the foundation for the next step. This includes performance indicators such as repetition rates, cycle times, and historical operator performance, which play an important role in formulating the evaluation process [6].

Figure 1 gives a bird's-eye view of how the system developed and shows how data and processes flow. It focuses on a simple integration of various features, including data recovery, statistics, and database updates. The system configuration also includes features such as database management, data processing, and user-friendly interface design.

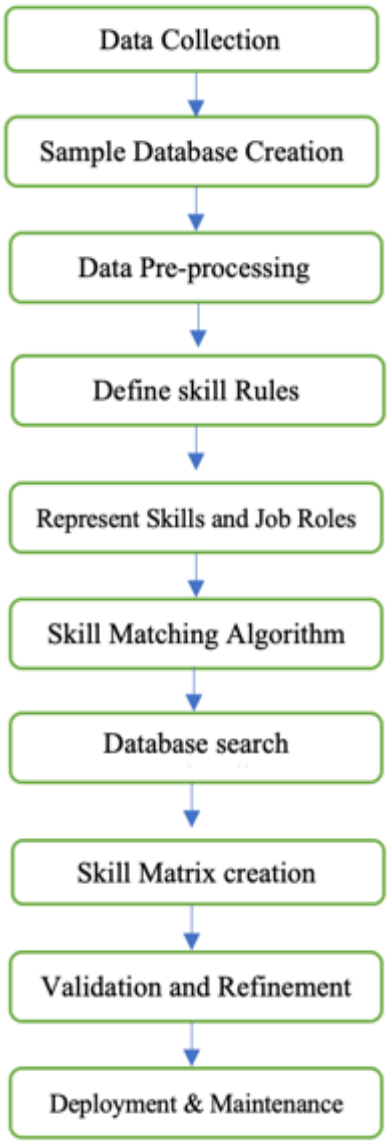

Figure 1. Steps of the proposed methodology.

Algorithms are at the heart of the system. This algorithm acts as an engine for calculating operator's ratings. It is based on well-defined rules and statistics. The algorithm considers important factors including rework rate, cycle time, and historical operator performance, and assigns ratings based on a weighted combination of this metrics This transparent and repeatable algorithm is the rating system backbone, ensuring accurate and objective results.

In parallel, the system relies on a series of formulas to transform raw data into statistical analysis. These products have been carefully designed to accurately measure the user's performance. Historical data are considered, cycle time is normalized, and weights are used. For rating professionals, this process approach facilitates objective decision-making and continuous improvement.

Following are the formulas used for the development of skill matrix:

Average cycle time=Total cycle time/Number of products worked (1)

Formula (1) calculates the average cycle time for an operator at a specific station. It divides the total cycle time by the number of products worked by the operator.

Rework rate=Rework count/Number of products worked (2)

The above formula computes the rework rate for an operator at a specific station. It divides the rework count by the number of products worked by the operator.

Normalized cycle time=(Cycle time-min. Cycle time)/(Max. Cycle time-min. Cycle time) (3)

Formula (3) calculates the normalized cycle time for an operator at a specific station. It ensures fair comparisons among operators by scaling cycle times relative to the minimum and maximum cycle times observed at that station.

Operator rating=4 × (1-rework rate)+2 × (1-Normalised cycle time) (4)

Formula (4) calculates the initial operator rating, combining rework rate and normalized cycle time with defined weights. It ensures that the rating is capped at a maximum of 4 for each operator at a specific station.

Weighted_normalised_cycletime=(weight_historical × historical_normalized_cycle_time + Weight current × current_normalized_cycle_time))/((weight$_{_historical}$ + weight$_{_current}$) (5)

Formula (5) computes the weighted rework rate at a station by combining the current and historical rework rates, providing a balanced perspective of an operator's rework performance.

Weighted_rework_rate=(weight_historical × historical_rework_rate + @weight_current × current_rework_rate)/((weight$_{_historical}$+ weight$_{_current}$) (6)

The above formula calculates the weighted normalized cycle time at a station by blending the current and historical normalized cycle times. It ensures a balanced evaluation of operator performance in terms of cycle time.

Revised_rating=(4 × (1-weighted_rework_rate_station) × 0.6+(2 × (1-weighted_normalized_cycle_time_station) × 0.4 (7)

This model calculates the adjusted rate of the worker in a station by combining the weighted rework rate and the weighted normalized cycle time with the predetermined load and represents the overall performance of the worker based on rework and cycle time plant. These considerations form the core of the algorithm, enabling the system to monitor employee performance, consider historical and current trends, and generate meaningful ratings for each employee at various levels.

The proposed approach to personnel assessment and evaluation uses a seamless combination of needs assessment, design process, complex planning, and design requirements The approach enables agencies to make evidence-based decisions, increase productivity, and makes them more efficient in their operations. By blending these elements harmoniously, an employee appraisal system is a valuable management tool.

Development of skill matrix

The creation and implementation of a digital skill matrix in a manufacturing or production environment involve a structured algorithmic process. This process not only aids in assessing operator performance but also facilitates the development of a digital skill matrix.

The first step in creating a digital skill matrix is the generation and preparation of data. This phase focuses on collecting and organizing data related to operator performance. The statistics consists of various of factors consisting of cycle time, rework rate, product count and operator identities. This information serves as the raw material for assessing and rating operator skills. With the records generated and organized, the subsequent step is SQL information retrieval and initialization. This ensures that the information is up to date and reflects the latest records. The initialization phase sets the stage for subsequent calculations and evaluations.

A crucial part of the digital skill matrix development process is the calculation of performance metrics. These metrics are critical in determining operator ability and productivity. The primary metrics include cycle time and rework rate. Cycle time measures the time an operator spends on a particular task. The algorithm computes average cycle times for each operator at each workstation. These average cycle times are indicative of operator efficiency and productivity. Rework rate quantifies how often rework is required for products associated with each operator. When products do not meet quality standards ("NOK" status), rework may be necessary. The algorithm performs calculations specifically based on rework instances attributed to operator failure rather than those arising from product defects. This distinction ensures that the skill matrix accurately reflects operator performance in terms of errors directly influenced by their actions, contributing to a more precise evaluation of operator capabilities. The algorithm tracks instances where rework is performed and calculates the rework rate for each operator. A lower rework rate is indicative of consistent high-quality production.

To effectively reward operators, the code uses a weighted approach. Rework rate holds a positive weightage (70%) compared to cycle time (30%). This leads to important priorities in the employee evaluation process. The algorithm also allows flexibility to adjust the amount of importance assigned to the project and cycle time, allowing companies to adjust their digital skill matrix to change business priorities. Historical data also contain legal elements. It holds information about each employee's performance over the years,

providing insights into their long-term performance. Historical records help score the employees and emphasize the importance of consistent overall performance.

The algorithm calculates weighted rework rate and weighted normalized cycle time to offer an in-depth evaluation of operator overall performance. These metrics combination current and historic information, with appropriate weighting, to provide a balanced view of operator skill. Once the revised operator ratings are determined, the final step is the result analysis and presentation. The revised ratings give insight into the personnel' overall performance, considering their current achievements and period of engagement. These expressions are rounded to the closest complete quantity for ease of interpretation. Also, the code updates the operator's score inside the MySQL database. This guarantees that this statistic is available for future use, reporting and growing the virtual competencies matrix.

In summary, the process of creating and implementing a digital skill matrix leverages a comprehensive algorithmic approach It begins with data generation and preparation, proceeds to SQL data retrieval, and involves performance metric calculations that consider cycle time and rework rate. The algorithm balances those metrics through weighting factors and carries historical facts to supply them the overall evaluation. Final steps and outcomes are analyzed and presented, after which used to create and preserve a digital skills matrix. This dynamic system provides a valuable tool for measuring and enhancing employee skills in a production environment.

Results and Discussion

The implementation of the digital skills matrix has produced vital effects that without delay effect operational performance and control of employees. When you run the program, its modifications the dimensions of the information from the SQL database. The first set of information from the database represents raw information of operator activities. But once work is accomplished, the information is translated into a structured skill matrix, which incorporates performance metrics along with cycle times and rework charges, all of which can be carefully classified through station and operator (Figures 2-4).

OperatorID	OperatorRating	RoundedRating	TotalProductsCount	ReworkRate	NormalizedCycleTime
E101001	0.35	0	175	0.5	0.25
E101002	3.2	3	220	0.8	0.87
NULL	NULL	NULL	NULL	NULL	NULL

Figure 2. Historical data of operators in a particular station named back cover assembly.

E101001	A	34	NOK	Sticker not pasted	OK	Fixture 2	Back Cover Assembly
E101002	B	14	OK	NA - PASS	OK	Fixture 2	Back Cover Assembly

Figure 3. Input associated with the station back cover assembly.

OperatorID	OperatorRating	RoundedRating	TotalProductsCount	ReworkRate	NormalizedCycleTime
E101001	1.32	1	176	0.65	0.4
E101002	1.2992	1	221	0.56	0.696
	NULL	NULL	NULL	NULL	NULL

Figure 4. Updated SQL database of the station named back cover assembly.

Operator ranking and matching

One of the primary use cases of a digital skill matrix is the ability to make immediate pointers on personnel allocations. When a selected position call is entered into the chart, the matrix takes into consideration elements together with cycle instances and rework quotes and ranks personnel primarily based on their historic overall performance employees with the very best rankings are presented as a they are properly desirable for that station. For tied sequencing, the device measures the remodel price and cycle time in that station, producing new guidelines.

Operator talent identification

The machine also gives a useful aid for identifying expertise. By getting into an operator ID, the device returns a list of rankings across all stations. The operator ID with the best score is located at the top of the list, presenting insight into the operator's center capabilities and areas of expertise (Figures 5 and 6).

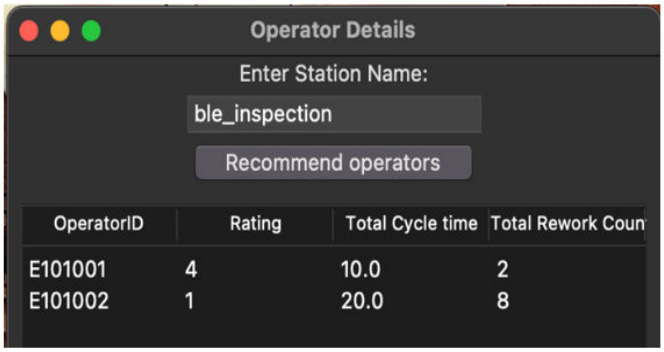

Figure 5. GUI display of the most suited employees for the station.

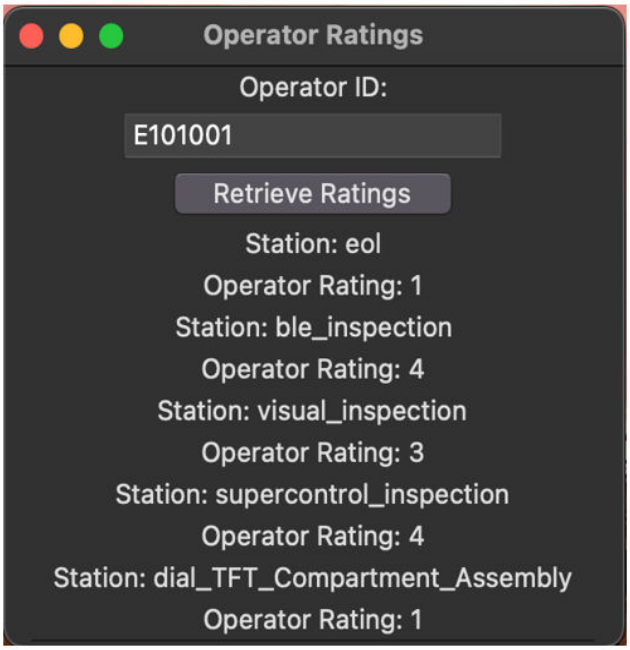

Figure 6. GUI display of the most suited station for a particular operator.

The system thus empowers organizations to make data-driven decisions in manpower planning. By converting the unstructured SQL records into a complete skill matrix, it offers real-time insights into how personnel are appropriate for specific positions and identifies individual operator strengths. These results underscore the practicality and efficiency that this algorithm offers to organizations in their quest for efficient manpower planning.

Applications of digital skill matrix in man power planning

In professional improvement, the digital skills matrix is a versatile device with a number of beneficial programs. First, it contributes to greatest exertions allocation with the aid of cautiously matching individual abilities with precise responsibilities, decreasing inefficiencies and streamlining operations, making sure powerful usage. Secondly, the skill matrix helps identify skill gaps, which informs targeted training and development initiatives, thereby improving operator proficiency and overall productivity. Additionally, the matrix's objective metrics, such as rework rates and cycle times, facilitate fair performance evaluations and recognition, motivating employees to excel. Lastly, the data collected through the matrix can inform succession planning, identifying potential leaders and ensuring a smooth transition of responsibilities. An additional feature is its customizability, allowing organizations to adjust the weightage between rework rates and cycle times based on their current priorities, whether emphasizing quantity or quality. Importantly, the algorithm distinguishes rework stemming from operator failure, not product failure, ensuring accurate performance assessment. In summary, the digital skill matrix is an indispensable asset in manpower planning, enhancing decision-making and resource allocation.

Conclusion

Digital skills matrix, powered by means of data-driven algorithms provides a revolutionary approach to workforce management in manufacturing and assembly environments. It efficiently processes raw SQL data, creating a structured skill matrix that provides valuable insights into operator performance. One of its key strengths lies in its flexibility, enabling organizations to customize weightage for rework rates and cycle times to meet the organization's priorities.

A particular feature is the system's ability to rank operators based on historical data while eliminating product-related biases. In the context of manpower planning, it proves invaluable by facilitating optimal workforce allocation and aligning operators with roles that best fit their skill sets. Additionally, it serves as a talent identification tool, offering operators guidance for career development and growth. To conclude, the Digital Skill Matrix enhances productivity, fosters a conducive work environment, and supports data-informed decision-making. This data-driven approach reshapes workforce management, empowering organizations to excel in an ever-evolving industrial landscape.

References

1. Ms. Mohini A. Lohar, and Sarita Dhawale, "An Analysis of Human Resource Skill Gap Through Hr Matrix-A Case Study" *Inter J Disaster Rec Bus Cont* 11 (2020): 2472–2485
2. Haque, Nizam Engr Md Eanamul, Ali Mahmud Nishad, Asharaf Ahmed, and Md Jubayer Ahmed. "A Study of Developing Skill Matrix System for Ready Made Garments Industries of Bangladesh." *J Textile Sci Eng* 12 (2022): 491.
3. S Janaki. Skill mapping with special reference to operators at Harita-NTI limited, Chennai.
4. Patil, Shweta J. "Python-Using Database and SQL." *Int J Sci Res* 8 (2019): 83-85.
5. Sultana, Najma, Smita Paira, Sourabh Chandra, and Sk Safikul Alam. "A brief study and analysis of different searching algorithms." In 2017 second international conference on electrical, computer and communication technologies (ICECCT), pp. 1-4. IEEE, 2017.
6. Liu, Han, Alexander Gegov, and Frederic Stahl. "Categorization and construction of rule based systems." In Engineering Applications of Neural Networks: 15th International Conference, EANN 2014, Sofia, Bulgaria, September 5-7, 2014. Proceedings 15, pp. 183-194. Springer International Publishing, 2014.

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