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Multi-Criteria Decision Making for Industry 4.0 TOPSIS System: A Case Study of a Home Appliance Manufacturer

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Abstract : In 2011, German Govt High Tech Industry 4.0 from a project in strategy Appeared, this is the computerization of production encourages. Indeed, The term "Industry 4.0". This is Hanover Introduced publicly at the fair. same year. Research significance: We are now in the fourth industrial revolution; This is Also referred to as Industry 4.0. Automation and Increasing smart machines and smart Sorting of factories, by data Assorted are highly efficient and Enables productive production of goods across the value chain. Methology: Alternative: Innovation, Technological, Social factors, Flexibility. Evaluation Preference: Equally Important (E), Weakly Important (WI), Strong emphasis (S), very strong emphasis (VS) and absolutely vital (AS). Result: the result it is seen that strongly important (S) is got the first rank where as is the Very strongly important (VS) is having the lowest rank. Conclusion: The value of the dataset for The Era of Industry 4.0 in TOPSIS Method (Similar for the best solution). By option order technique shows its results in strongly important and top ranking.

Introduction :

We are now in Automation and increasing smart machines and smart Sorting of factories, by data Assorted, more efficient and Enables productive production of goods across the value chain. Industry 4.0 for business owners their Optimize every aspect of operations Empowering to control and understand, and To increase productivity and improve processes, Leverage real-time data to drive growth allows Overall, the Fourth Industrial Revolution is the four major in business Consequences—customer expectations, Product development, collaborative innovation and enterprise Forms. A to maintain Germany's industrial competitiveness A coherent policy by the German government At the beginning of Industry 4.0 to create structure was created. Internet of Things, Internet of Service, Industrial Internet, Advanced Manufacturing and Smart Factory internationally Related terms used. Industry 4.0 One recently launched by the German government It is a strategic initiative. The goal of this initiative is to create a new Digitizing the capabilities of technologies and It is the replacement of industrial production by exploitation. TOPSIS alternately selects short methods. It's a simple one a method widely applicable to mathematics. Model. Further, Relying on computer support, this is the most suitable practice is proper. Technique for Priority Ranking Analysis of technique. of this technique The main idea is that the alternative is very Closer positive better solution and more The best solution to the negative.

The Era of Industry 4.0 :

CEFRIO, Based on literature review of real-time data acquisition Basically allowing for decentralized decisions processes, products and services Industry 4.0 as a set of initiatives to improve Universal definition by definition Accepted. [1] The The fourth industrial revolution, i.e. Industry 4.0, is intelligent automation This is the latest movement in technology. In this new era, innovative information Application of modern manufacturing capabilities in the context of integration of technologies, Key to economic competitiveness as illustrated in Industry 4.0 Smart by redefining the role of role people owns factories. aims to create. [2] Germany developed Industry 4.0, the US The Smart Manufacturing Leadership Alliance proposed, China launched Make China 2025. It is production led to significant financial support for research; [3] The Initiatives open our vision, career 4.0 the future of education How to design and what students know after graduating from college and to have skills, when workforce restructuring What are the building blocks and connections to accelerate? It made me think about that. Education supply chain. Education Distribution A whole Industry 4.0 era has emerged in the chain.[4] Industry 4.0 is computerized manufacturing From the German government program to develop derived word. Industry 4.0 of the 18th century From Industrial Revolution to "Fourth Industrial Revolution" Also referred to as the First Industrial Revolution was steam power It improved the production of iron and textile industries using [5] Digital SC derives the Methodological principles of risk analysis and Management using Industry 4.0 principles Integrates them into decision making. Risk of disruption Digital Supply Chain (SC) for Management It's twins framework can be used to design.[6] Like IoT, Machine Learning and Block chain As technologies are found to improve process efficiency, Many Indian companies have started adopting Industry 4.0. For example, Tata Power Ltd. with real-time data to its customers Better manage power consumption of power plants It has also developed a digital platform to improve efficiency. [7] A shift This type of activity is new and innovative business Paving the way for allows you to. [8] Mistakes can also come from sources other than mechanical degradation, and The potential of

ML in securing cyber security are fully discussed. Industry 4.0 Environment A major concern in the system is human operators and is the share of workers. For this purpose, ML-based A comprehensive overview of human-machine interaction techniques presented, [9] The technologies that drive Industry 4.0 are obsolete, Manufacturers' initiatives are isolated, If fragmented, risks Prevention of workplace health and safety Earlier gains in management are at stake. [10] When vague and uncertain Future directions in technology and Alternatives, institutions It is well accepted that development strategy should be developed. Industries 4.0 and its The German equivalent of "Industries 4.0" is manufacturing in the Industry 4.0 era To interact Upcoming future technology like digitization Appropriate to support their planning with developments Business model. [11] Doing Factor analysis and more in Industry 4.0 literature Dimensional measurements. Information Technology, Education and Training, Productivity and National Strategy That the main problems of China's manufacturing development they have found. [14] The transition to Industry 4.0 is significant That would bring about improvements expected productivity and flexibility metrics, and, at the same time, to open up new design opportunities, given Intrinsic opportunities of FRPs related to selection and Distribution of raw ingredients, addition of fillers and additive manufacturing, and material design. Robotic and additive systems encourage the design of case-specific requirements.[15] With large amounts of data generated from production Organizational, distributed and decentralized production format, data management in Industry 4.0 must cross locations, countries and even continents.[16] According to these authors, Industry 4.0 is value Development of traditional supply chain plans It has significant potential for change. Nevertheless, this phenomenon is more evident throughout education No and social.[17] This study is highly Gaps in required quality skills and knowledge Quality professionals industry by understanding and working 4.0 to ensure that it can be adapted to suit and correct time. Studies of the current role of quality managers, internal consultants, including researchers, practitioners and educators; show a different view of the role of quality. efforts. [18] The origin of Industry 4.0 is underground Virtual technology, artificial intelligence and Quantum technology is a global strategy Following rapid growth get the economy online The project was forced to establish. This is new Benefits associated with revolution. [19] Industry 4.0 is a concept and a big one Communication between buildings and the maintenance department of companies with high physical assets, for aspects such as resource renewal, performance and monitoring, exchange and interaction between people, machines and facilities. [20] Researchers from other fields are finding advancements Process and Supply Chain 4.0 Virtualization in Industry Building supply chain flexibility and Ensures supply chain optimization. Visibility, establishing collaborative networks, end-to-end Digital Achieving integration and leveraging personalized discovery data, [21] Industry 4.0 can be a great option to help businesses overcome Performance-related organizational Challenges within and across borders and effectiveness.[22] Industry 4.0 is automation in manufacturing and indicate trends in data transmission. This is Requirements, physical monitoring processes, networking Multiple machines, predictive maintenance and quality control are consumer analysis. 4.0.[23] The industrial environment is currently undergoing a fourth phase of revolution is experiencing, so-called Industry 4.0. This revolution brought many new digital technologies Integrate and by a radical change in production processes classified. [24] With the Production of large volumes of data from production systems, Distributed and decentralized Data Management 4.0 in Manufacturing, Industry must transcend locations, countries, etc. [25]

TOPSIS Method (Similar to Ideal Solution technique of priority order by) :

Conclusion normalizing the matrix; positive ideal solution and normalizing the matrix; positive ideal solution and Compute the negative ideal solution separations. An alternative from PIS and NIS. Proximity in descending order to receive replacement [1] The TOPSIS method was first introduced by HWANG and YOON Introduced; it proposed several For solving criterion decision problems. This According to the technique, the best alternative is closer to the positive best solution Presence and negativity are far from ideal solutions is far away. [2] Order by similarity of best solution (TOPSIS) approach multiple answers using optional technique an attempt was made to improve. This method is of any kind Ability to improve problem and any number they concluded that it had answers. [3] The aim of the present work is Thermal performance of CFWCT and MCDM-TOPSIS To investigate the optimum operating conditions of a cooling tower, Installed in a specific location using the method is operated. Heat and mass in CFWCT Exchange equations were presented and CFWCT's Thermal efficiency was evaluated with fill height. [4] The application of those MCDM techniques are mostly Conservative and approximate or sub-optimal leading to solutions. Therefore, in this thesis, DESIGN OF EXPERIMENTS AND TOPICS METHODS Calculated TOPSIS Along with the marks, two NTM as EDM and WEDM processes Build regression meta-models to search for optimal parameter combinations for processes. [5] The Calculated TOPSIS Along with the marks, two NTM as EDM and WEDM processes Build regression meta-models to search for optimal parameter combinations for processes. [6] Two Probability Using Relative Entropy A comprehensive weight between distributions is calculated. Calculated detailed weights Basically, air quality measurement is based on the TOPSIS system is evaluated using [7] Has wide Applications and better In multi-attribute decision making models One. In this method, m replaces n evaluated by attributes, and each The problem is an n-dimensional space with m points is a geometric system. [8] Applied fuzzy TOPICS and network optimization techniques to solve Choice of stem location in deep multiple or body deposits problem Based on TOPSIS system, highway Superstructure selection in the conceptual design of the bridge They are an optimization-based method for solving presented. [9] Quantifying impacts Water level using TOPSIS methodology and quality and weighting value objective and combined with sets of subjective values. [10] SCR is estimated using Fuzzy TOPSIS technique. A typical TOPSIS method of SCR estimation is, Ambiguity or imprecision of assessment Linguistic Limitation in Dealing To overcome this limitation, Fuzzy-TOPSIS method is followed. of risk factors Linguistics to estimate ratings and weights Words are used and criteria. [11] Time, scales, with unknown weights Extended TOPSIS under neutrosophic synthesis An optimization

method for determining weight information model method proposed. [12] available to achieve the required criteria Identify the optimal alternative from various alternatives TOPSIS method is used to see. In this manner, the compromise ranking Basically the optimal solution is selected and selected The solution is positive and the shortest distance from the ideal solution is negative must also have the greatest distance from the ideal solution. [13] Spatial and temporal characteristics of floods CV-TOPSIS method for disaster risk assessment done In the first part, every year Considered a watchdog for the economy, too Flood risk using CVTOPSIS method 263 observations were examined to obtain scores. [14]. It aims at the performance evaluation of the distance using the DEA method in the academic year of the academic Departments of Public Universities in Turkey TOPSIS method. This results in efficient decision making This study also compares and ranks units aims to A measure of competence in themselves [15] The The software is based on the AHP method and Weights for selected criteria determines. Final ranking of technologies and hierarchy. [16] One of the known classical MCDM methods for optimal solution (TOPSIS) is a technique of order efficiency through similarity. TOPSIS is the chosen alternative positive ideal A negative ideal is also the shortest distance from the solution The idea is to be far from the solution based on the other hand.[17] According to the TOPSIS method, the observed selected hybrid The ranking of different methods in models is usually very high Given the Highest ranking. On the other hand, the M5T Hybrid LSSVM, ANFIS, MLP, RBF and GEP models surpasses [18] A due to alternative drugs should be given will be selected [19]

Analysis and Discussion :

This Table 1 TOPSIS of the Era of Industry 4.0 Alternative: Innovation, Technological, Social factors, Flexibility. Evaluation Preference: Equally Important (E), Weakly Important (WI), Strong emphasis (S), very strong emphasis (VS) and absolutely vital (AS). Innovation the Absolutely important (AS) it is seen that is showing the highest value for strongly important (S) is showing the lowest value. Technological sale it is seen that strongly important (S) is showing the highest value for Very strongly important (VS) is showing the lowest value. Social factors it is seen that absolutely important (AS) is showing the highest value for weakly important (WI) is showing the lowest value. Flexibility and it is seen that p is showing the highest value for Very strongly important (VS) is showing the lowest value.

TABLE 1. TOPSIS Industry Era 4.0

Data collection				
	Innovation	**Technological**	**Social factors**	**Flexibility**
Equally important (E)	81.08	459.53	249.15	222.05
Weakly important (WI)	79.12	444.97	220.69	227.30
Strongly important (S)	64.08	556.58	243.18	223.10
Very strongly important (VS)	73.17	436.28	223.60	217.59
Absolutely important (AS)	83.33	556.41	327.96	218.89

Alternative: Innovation, Technological, Social factors, Flexibility. Evaluation Preference: Equally Important (E), Weakly Important (WI), Strong emphasis (S), very strong emphasis (VS) and absolutely vital (AS).

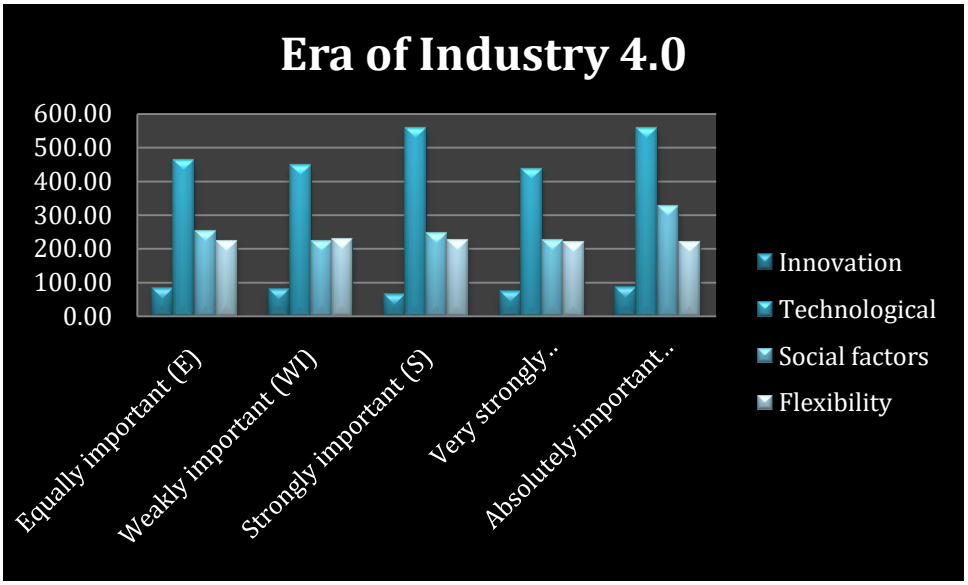


FIGURE 1. TOPSIS of the Era Industry 4.0

Figure 1 Tapsis of the Industrial Age 4.0 shows graphical representation Enhance the Innovation it is seen that is showing the value Equally important (c) 81.08, Weak Importance (WI) 79.12, Strong significance (S) 64.08, very strong Importance (VS) 73.17, absolutely Important (AS) 83.33. Technological it is seen that is showing the value Equally important (c) 459.53, Weak

Importance (WI) 444.97, Strong significance (S) 64.08, very strong Importance (VS) 73.17, absolutely Important (AS) 556.41. Social factors it is seen that is showing the value Equally important (c) 249.15, Weak Importance (WI) 220.69, Strong significance (S) 64.08, very strong Importance (VS) 73.17, absolutely Important (AS) 327.96. Flexibility it is seen that is showing the value Equally important (c) 222.05, Weak Importance (WI) 227.3, Strongly important (S) 223.1, Very strongly important (VS) 217.59, Absolutely important (AS) 218.89.

TABLE 2. Squire Rote of matrix

Squire Rote of matrix			
6573.966	211167.821	62075.7225	49306.203
6259.974	197998.301	48704.0761	51665.29
4106.246	309781.296	59136.5124	49773.61
5353.849	190340.238	49996.96	47345.408
6943.889	309592.088	107557.762	47912.832

Table 2 shows the Squire Rote of matrix value.

TABLE 3. Era of Industry 4.0 in Normalized Data

	Normalized Data			
	innovation	Technological	Social factors	Flexibility
Equally important (E)	0.474	2.69	0.44	0.45
Weak Importance (WI)	0.463	2.602	0.386	0.5
Very Important (S)	0.375	3.255	0.425	0.4
Very strongly important (VS)	0.428	2.551	0.391	0.4
Absolutely important (AS)	0.487	3.254	0.573	0.4

Table 3 Normalized Data shows the informational set for the Innovation, Technological, Social factors, Flexibility. The Normalized data is calculated from the data set value is divided by the sum of the square root of the column value.

TABLE 4. Weight

Weight			
0.25	0.25	0.25	0.25
0.25	0.25	0.25	0.25
0.25	0.25	0.25	0.25
0.25	0.25	0.25	0.25
0.25	0.25	0.25	0.25

Table 4 Weight shows the informational set for the weight all same value 0.25.

TABLE 5. Era of Industry 4.0 in Weighted normalized result matrix

	Weighted normalized result matrix			
Equally important (c)	0.118544	0.672	0.109	0.112
Weak Importance (WI)	0.115679	0.651	0.096	0.115
Very Important (S)	0.093689	0.814	0.106	0.112
Very Important (VS)	0.106979	0.638	0.098	0.11
Absolutely Important (AS)	0.121834	0.814	0.143	0.11

Table 5 Weighted normalized decision matrixes show the informational set for the Normalized Data multiplication Weight we used the formula.

TABLE 6. Era of Industry 4.0 in Positive Matrix

	Positive Matrix			
Equally important (c)	0.1218	0.8138	0.0964	0.1097
Weak Importance (WI)	0.1218	0.8138	0.0964	0.1097
Very Important (S)	0.1218	0.8138	0.0964	0.1097
Very Important (VS)	0.1218	0.8138	0.0964	0.1097
Absolutely Important (AS)	0.1218	0.8138	0.0964	0.1097

Table 6 Positive Matrix shows the informational set for the value Innovation 0.1218, Technological 0.8138, Social factors 0.0964, Flexibility 0.1097.

TABLE 7. Era of Industry 4.0 in Negetive matrix

	Negetive matrix			
Equally important (c)	0.094	0.63787	0.143	0.114569
Weak Importance (WI)	0.094	0.63787	0.143	0.114569
Very Important (S)	0.094	0.63787	0.143	0.114569
Very Important (VS)	0.094	0.63787	0.143	0.114569
Absolutely Important (AS)	0.094	0.63787	0.143	0.114569

Table 6 Positive Matrix shows the informational set for the value Innovation 0.094, Technological 0.63787, Social factors 0.143, Flexibility 0.114569.

TABLE 8. Era of Industry 4.0 in Si Positive & Si Negative & Ci

SI Positive	Si Negative	Ci
0.142493	0.054	0.276507
0.16337	0.053	0.246003
0.02994	0.18	0.857224
0.176517	0.048	0.212884
0.046868	0.178	0.791508

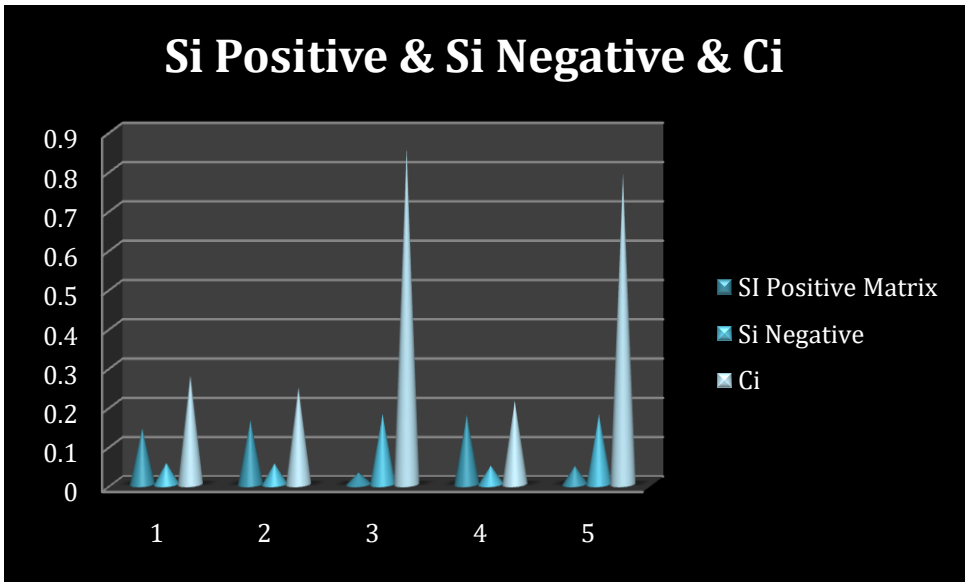


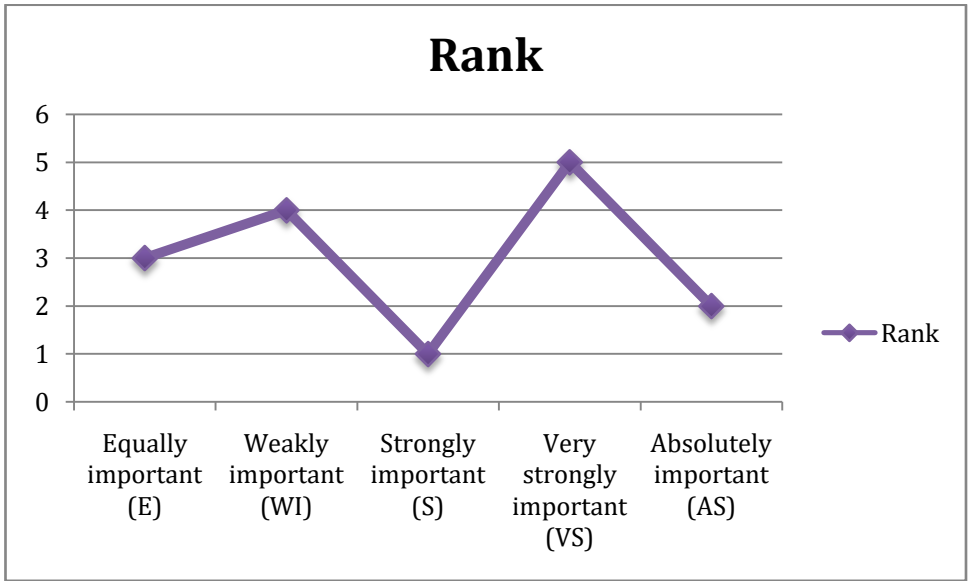
FIGURE 2. Era of Industry 4.0 in Si Positive & Si Negative & Ci

Figure 2 Si Positive & Si Negative & Ci shows the graphical representation

TABLE 9. Era of Industry 4.0 in Rank

	Rank
Equally important (E)	3
Weakly important (WI)	4
Strongly important (S)	1
Very strongly important (VS)	5
Absolutely important (AS)	2

Table 9 Rank shows the informational set for the Equally important (E) is in 3rd rank, Weakly important (WI) is in 4th rank, Strongly important (S) is in 1st rank, Very strongly important (VS) is in 5th rank, Absolutely important (AS) is in 2nd t rank.



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Conclusion :

The transition to Industry 4.0 is significant That would bring about improvements expected productivity and flexibility metrics, and, at the same time, to open up new design opportunities, given Intrinsic opportunities of FRPs related to selection and Distribution of raw ingredients, addition of fillers and additive manufacturing, and material design. Robotic and additive systems encourage the design of case-specific requirements. Doing Factor analysis and more in Industry 4.0 literature Dimensional measurements. Information Technology, Education and Training, Productivity and National Strategy That the main problems of China's manufacturing development they have found. Applied fuzzy TOPICS and network optimization techniques to solve Choice of stem location in deep multiple or body deposits problem Based on TOPSIS system, highway Superstructure selection in the conceptual design of the bridge They are an optimization-based method for solving presented. It aims at the performance evaluation of the distance using the DEA method in the academic year of the academic Departments of Public Universities in Turkey TOPSIS method. This results in efficient decision making this study also compares and ranks units aims to A measure of competence in themselves the result it is seen that strongly important (S) is got the first rank where as is the Very strongly important (VS) is having the lowest rank.

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