Construction Safety Management Systems Using PROMETHEEE Method

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Abstract. *Construction safety management is at the construction site safe working environment security to ensure to control activities a method that can be used. Planning and design taken during the process results of the construction project when the protection is largely affected. Construction and demolition sites, labor protection, and health hazard the result is unique hazards and risks causing professional safety and health management protection of systems organizations and health hazards continue to detect and remove help, incident possibilities reduce, to regulations compliance and risk-reduction implement interventions. Construction industry sites employee health and safety very dangerous to work with one of the workplace environments. Manufacturing processes, labor intensive characteristics, and occupational accidents due to the construction industry the greater the risk, the greater it is scale of financial losses, and the worst the company results from reputation. Construction in the construction industry site security is very important this is an important requirement mostly on project sites is ignored. Correct without safety regulations, hazards of the construction industry and because of the dynamic environment, staff small and large are prone to accidents. Security management systematic risk management in detection, and with it related risks can also help control, at the same time this control activities of the construction site useful in aiding protection   it promises to be. Safety management process roughly the following steps outlines: planning related to the workplace at the stage identity hazards and accident or to avoid property damage ensure construction safety appropriate restrictions for making and advance the determination of the step. Accidents possible actions early detection, safe practices followed and safe conditions whether maintained monitoring of verification work.   Neighbors are public and private protection of assets at all levels of the organization effective communication implementation and promotion. Safe operating modes attractive to use regularly with incentive programs safety education and training providing. Constant professionalism health and safety compliance with regulations. PROMETHEEE is a priority for assessment enrichment Ranking system and its interactive help Descriptive complementary geometric analysis known as PROMETHEEE methods. In this, The PROMETHEEE method is the best solution from the analysis The shorter the distance and the longer the negative-ideal solution Determines the solution with the distance, but of these distances, The comparison was not considered significant. Alternative is Safety Commitment by Senior Management, Competency Profiles, Safety Climate, Project Management, Safety Requirements and Incentives, Safe Working Environment/ Conditions. Evaluation preference is Government building, Private building, Civil engineering, Industrial building. From the result it is seen that Government building is got the first rank where as is the Industrial building is having the lowest rank. Government building is ranked first and industrial building is ranked lowest.*

Keywords: construction safety management systems, PROMETHEE, building.

1. INTRODUCTION

In the 1980s, in the construction industry security management system (sms) was introduced also, building construction in some industries including sms is mandatory power to execute to provide, 24 november 1999 in hongkong 20 facto-19 companies and industrial companies security management regulation introduced. 21 therefore, in improving construction safety evaluating the effectiveness of sms and hongkong impact on implementation 22 factors that cause need to find out [1]. Construction sites of the world in the most dangerous workplaces are one. In 2008, in singapore's construction industry 6.9 deaths per 100 000 persons there were, it was in the country in all industries per 100 000 employed persons 2.8 deaths. Worst of the industry explain safety performance similar figures America in Taiwan and found in spain. Over the years, regulators, architecture,

engineering, and construction (aec) industry, and construction companies have safety of workplaces different approaches to improve divided, which is common one of the interventions is vocational safety and health management system (oshms) implementation [2]. Many per occurrence of an incident contributing factors. Useful to create an sms, plan advance safety performance principles of control defining and different integrated of managers results safety management how they affect it is important to understand. Big scale industrial construction inherent complexity in projects   for practitioners with safety assessments different analysis to help methods and models although developed, data fusion, analysis, and simulation completing the steps is complex, and labor-intensive the process remains [3]. Useful sms on one site to know if there is every six months sms to be censored want the problem is, so far a company to objectively measure sms performance, stable and assessable a standardized audit tool nothing. Various securities also for auditing standards of consultants there is a big discrepancy between sms and sms performance of audit for the need to upgrade in response, construction sms performance of the company   auditors to assess tools that can be used develop and test methodology the purpose of this thesis is to propose is the purpose. This purpose is important because the industry has a standard auditing system compliance and security for auditing purposes a benchmark can be created [4].The construction industry contributes to a large proportion of industrial injury and mortality. It is of high importance to evaluate the effectiveness of the safety management system (sms). In particular, it is necessary to compare the quality and level of achievement of sms and the safety performance of a construction project. However, a sizeable sample of construction accidents is often not available. Therefore, possible proxies to indicate the safety performance were established. Moreover, the motivation factors which characterize the quality and level of achievement should be identified. In this study, a structural model has been established to examine the relationship between sms implementation and the operational & safety performance of construction projects [5]. All construction industry high accident rate industries too having ratios, based on the severity of injuries for very serious accidents it is also a place. Worldwide, in the construction industry at least 108,000 a year workers are killed, it's all risky business 30% of accidents. In america, about 21.1% of fatal accidents occur in the construction industry, it is in the total employment of the country only 8.5% is present. In england, construction in 2017   deaths in the field, occurs in all industries than average deaths there were more. In singapore, 29% of workers in construction are in the field, but 40% of occupational accidents occur in business. Similarly, in developing countries, other industries than the construction industry the associated risks are threefold six times more than the first [6]. For quality, environment, and safety the philosophy behind ~qes management systems is by various contractors it is an accepted concept. Also, any environment, health, and safety regulations and without violating regulations output produced compliance with customer satisfaction confirmation process has been created. A useful qes scheme for a quality product in addition to guaranteeing reduces costs and increases productivity [7]. Iso 9000 standards in many countries active in the construction industry encouraged, building contractors as a means of quality assurance has some countries (for example, australia, hongkong, and singapore) all contractors for public sector building projects before being eligible to bid, to be certified to iso 9000 requirements demand that ie to iso 9000 standards certified quality management systems (qms) are now many countries in the construction sector is a ubiquitous feature [8]. Construction is complex as is the process, there are a variety of stakeholders by the demands of work work under constant challenge doing for every job many safety and danger there will be factors, as mentioned quality and safety management settings should be installed. Organizational structure, communication, clear instructions, safety culture, codes and standards, training, including leadership and responsibility many risk factors in the workplace impact public safety it is recommended to make this the objective of the study is by workers' perceived safety management contributes to the success of the organization the most influential factor is to determine. Available in optimizing the utilization of resources \ this may help in administration [9]. Throughout the construction industry security issues are important to have gained importance. Many around the world construction companies, injuries to reduce and eliminate diseases, at their construction sites safe working environment to provide safety and health and environmental management activating systems [10]. Occurs at construction sites in almost all accidents 80% due to unsafe human behaviors occurs, most deaths workers from above falling, striking or being struck by moving objects or particularly moving being hit by vehicles caused by with 24 deaths in 2012 construction is very dangerous classified as a profession. This is from the previous five years 26.3% above the average, this worsened the situation means to come. The latest over the years, by the hksar government 10 major projects have been introduced by the way, industrial labor has suffered a shortage, and thus many companies are suitable enough those without work experience are employed [11]. The construction is unique so much because of nature in hazardous industries is one. According to international standards, construction site safety in china records is poor. In the Chinese construction industry state of security management exploring construction sites risk-sensitive activities explore and construct affect the security of the site identifying factors that is the purpose of this article. Of personal protective equipment lack of regular protection meetings and safety training including security management conduct of said contractors that is very worrying the findings are revealing [12]. The purpose of this study is to construct the security of companies and improve health management aims, the British standard safety management system, principles of bs8800, and especially the theories of construction in hongkong for use in the field. With the help of bs8800 (bsi, 1996). Construction safety management main processes of the organization execution, for key processes creating

priority orders, for various types of constructions of priorities between differences in rows findings are objectives. Companies, priority orders a potential problem with analysis identify areas and improve recommend efforts. Fitting and internal renovation besides, civil engineering, rehabilitation, foundation, building, and tunnel all such construction departments are also included in this scheme [13]. These essential elements can be divided into four categories: directive, operational, review, and advertising. Guidance purposes, of the company top management security policy and the security system in security based on structure reassuringly, at the same time skilled safety coach's internal security and hygiene formulation of rules, training organizing and conducting and emergency preparedness in project implementation they help. Excellent functionality objectives, well organized a safety inspection is planned, risk control planning and accident/incident investigation are of the construction project scheduled for regular operation. [14]

2. MATERIALS & METHODS

2.1. Alternative: safety commitment by senior management, competency profiles, safety climate, project management, safety requirements and incentives, safe working environment/ conditions.

2.2. Safety commitment by senior management: Management for safety commitment is security a specific climate and important component, which is their manager's safe work to the extent of respect and support and for the safety of workers about being dedicated the sentiment of the workers indicates. Occupational health and high-security managerial commitment is occupational health and in all aspects of security, the highest level of management refers to direct participation, in health and safety company best practices with the sole aim of achieving avoid legal punishment.

2.3. Competency profiles: A talent profile is a to succeed in the role in the specific behaviors required focuses and works may be included in the description. Of this the material is in your company you for every job create a talent profile don't have to. For many jobs a talent profile to match you may have.

2.4. Safety climate: A climate of safety a at a given time on security in the company is perceived value. Security climate, employees within the company the importance of security shared opinions about defined as, the patient and of health workers with safety and consequences related, more health worker injuries, exposures and safe work compliance with procedures.

2.5. Project management: Construction project management is the beginning of a project from development to completion up to direction, regulation, and defined as supervision. Of construction project management the ultimate goal, activity, and both in terms of budget of the client for the potential project complete the requests is to satisfy. Construction of the management process five phases in traditional pm reflecting the project initiation, planning, implementation, monitor, and grouping all once completion targets are met, project closure.

2.6. Safety requirements and incentives: Security requirements are for risk reduction purposes the requirements are limited. As with other requirements, they first can be mentioned at a high level, for example, given the need to reduce risk. Safety promotion scheme is safety in the workplace meet and exceeds standards one that motivates employees a reward-based initiative. safety incentive programs are in place promote safety practices and will be done by employees highlight effective security procedures.

2.7. Safe working environment/ conditions: In construction at the project level safety performance of the project is often among the influencing factors among the factors cited safety training, a safe enabling work environment, and a safe plant and activation of equipment are included. Tall work in places. Improper soiling proper security without taking precautions working in lines. Unguarded floor openings and excavations

2.8. Evaluation preference: government building, private building, civil engineering, industrial building

2.9. Government building: Secretariat building or central secretariat means the government of india governing cabinet secretariat is the location. In the 1910s it was built by the cabinet of india it is home to some important ministries. Of democratic government in the world, a highly recognized icon the united states capitol 1800 congress from the year contains our country congress writes laws the meeting place and the presidents of the republic inauguration, their annual state of the union messages providing also the capital.

2.10. Private building: A private building is a building or that part of a building, this is usually by the public infrequent, or not open. Private houses or private residences are common for members of a family only owned. That more than one building in case of residence of families it is a multi-family private residence called something, in particular land or buildings, that is instead of govt., a to a particular person or entity belongs to environmental regulations value of private property when reducing, compensation activists are asking the government to provide.

2.11. Civil engineering: Civil engineering is a professional engineering department, which is roads, bridges, canals, dams, airports, sewage systems, pipelines, and structure of buildings' general components physical and including tasks of the naturally built environment design, construction, and also deals with maintenance. And railways. Civil engineering traditionally several sub-categories are separated. Military this is after engineering the second oldest is engineering considered a sector and is in military engineering from non-military to distinguish engineering is

defined. Civil in engineering public sector municipal public works departments first central government agencies even in the private sector domestically operated companies the first global fortune up to 500 companies can be held.

2.12. Industrial building: Industrial architecture is serving the industry design of buildings and construction. Such buildings begin in Britain, during the industrial revolution gained importance, and a pioneer of modern architecture some of the structures are industrial a building is a building or it is part of its goods or materials fabricated, assembled, or processed, assembly factories, laboratories, etc. Power plants, refineries stations, gas plants, mills, dairies, and factories. A few examples are malls, retail stores, or restaurants. Industrial construction, however, the building is especially the production of goods for handling business. Some of these types of construction examples are warehouses, assembly plants, or power plants.

2.13. PROMETHEE Method: Priority ranking for assessment saturation methodology and PROMETHEE us are interactive its descriptive complementary geometric analysis for help known as methods. Of mathematics and sociology basically, early 1980s PROMETHEE us and gaia created this system since then it has been extensively refined. This is specific in decision-making is use and business, government such as institutions, transport, health and education in different types of decision-making environments across sectors used all over the world. A "correct" instead of pointing out the result, for decision makers there is the target and more relevant to understanding the problem, the PROMETHEE method helps to find alternatives. This is a decision maker problem, with its paradoxes and creating integrations, of actions identifying and measuring clusters, and key alternatives and built-in reasons a detailed and logical to highlight provides structure. Natural stream networks have been changed. This process is the flood of urbanization occurs during rainy season, especially on high gradients, proper transmission systems and drainage system absence leads to scarcity. Urban stream, shower hotel management, process evaluation to be done. Ambiguous change is the quality of time for criteria, judgment when it was introduced standardized, this time value and comparison criteria for determining importance based on the analytic hierarchy process (AHP) is used in conjunction with next part, PROMETHEE us provides advanced decision making in a production environment [11]. PROMETHEE method of expert ideas fundamentally unpredictable, this is swmm storm water various regional factors that may influence considering, the accuracy of the results of the study PROMETHEE process in drainage system, which PROMETHEE method while increasing let's use the results of the flood drainage results lack of acceptable capacity flood drainage change implies; as a result, the drainage system capacity is high. Various in practice models and multiple ratings five criteria for deciding on just six cover cars [12].Prove ability PROMETHEE analysis, imagination cars have names that suggest characteristics, because we cheat. Basically TOPSIS is MCDM while PROMETHEE is one of the methods, it is a powerful one system, it has common criteria based on this, it is up to the decision maker allows you to select one of the categories. Geothermal village community for four in the low north of greece using enthalpy alternatives PROMETHEE to evaluate proposed projects method was used. Economic in the region while activities are limited, over time step out of the traditional agricultural sector develop, develop and new for workers there is a pronounced demand for jobs such as providing accommodation [13]. PROMETHEE is a well-known decision maker it's about the support system, which is the multifaceted support system customizes the entire package with intelligence provides reorganized custom information section or the absolute ranking will be used one of the alternatives is relative to PROMETHEE provides less mathematical complexity, decision making at PROMETHEE all experts in action are involved. One does not become an attractive system. The PROMETHEE method is based on expert opinion has in unpredictable PROMETHEE mode swmm processes various factors of storm water drainage may affect, therefore, using the PROMETHEE method when the accuracy of the results should be increased [14]. The drainage system of the area is not capable of accommodating the change in flood. According to the results, rainfall does not occur during the return period of 1 year, at the same time some sub-catchments return during flood years. The result is the dimensions drainage system of the study area and indicates no properties. Perfect design for flow. It is one of the important sub-basins leading to urban flooding. PROMETHEE is an mcdm system from france (1982). It was introduced by france and vincke and expanded by france and marche. To derive area rankings by calculating incoming and outgoing flows advanced PROMETHEE methods and calculation of net flows complete PROMETHEE with included alternatives to get ranks. In PROMETHEE methods, a defined pair sequence based on selection, alternatives are ranked based on [15].The PROMETHEE technique is understood and might handle numerical information with affordable size and accuracy. It is in most strength exploitation initiatives, in particular now not within the early levels of improvement. Most records can most effective be approximate. The PROMETHEE system overcomes this downside through moving the records in the form of extended fuzzy numbers. The PROMETHEE technique is understood and the PROMETHEE us technique is dreamy and precisely manipulable. The PROMETHEE approach is thought and may manage numerical facts with affordable size and accuracy. This isn't the case with the maximum energy-efficient projects, especially inside the early levels of improvement. Most information can most effective be approximate. PROMETHEE extended fuzzy data handling [16].

3. RESULT AND DISCUSSION

TABLE 1.construction safety management systems

	Safety Commitment by Senior Management	Competency Profiles	Safety Climate	Project Management	Safety Requirements and Incentives	Safe Working Environment / Conditions
Government building	95	59	97	10	20	18
Private building	87	60	92	15	25	20
Civil engineering	90	74	100	20	35	30
Industrial building	82	69	89	17	30	25
Max	95	74	100	20	35	30
Min	82	59	89	10	20	18
max-Min	13	15	11	10	15	12

Table 1 shows the Alternative: Safety Commitment by Senior Management, Competency Profiles, Safety Climate, Project Management, Safety Requirements and Incentives, Safe Working Environment/ Conditions. Evaluation preference: Government building, Private building, Civil engineering, Industrial building. Shows the maximum and minimum output of each value.
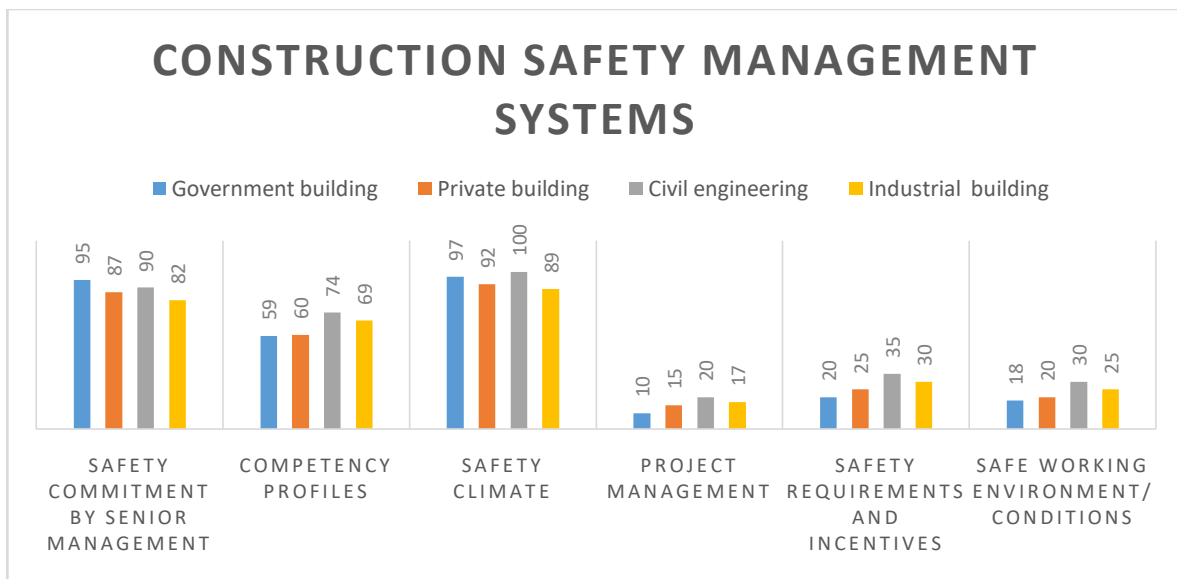

FIGURE 1.construction safety management systems

Figure 1 Shows the Safety Commitment by Senior Management it is seen that Government building is showing the highest value for Industrial building is showing the lowest value. Competency Profiles it is seen that Civil engineering is showing the highest value for Government building is showing the lowest value. Safety Climate it is seen that Civil engineering is showing the highest value for Industrial building is showing the lowest value. Project Management it is seen that Civil engineering is showing the highest value for Government building is showing the lowest value. Safety Requirements and Incentives it is seen that Civil engineering is showing the highest value for Government building is showing the lowest value. Safe Working Environment/ Conditions it is seen that Civil engineering is showing the highest value for Government building is showing the lowest value.

TABLE 2. Normalized matrix

Normalized Matrix						
	Safety Commitment by Senior Management	Competency Profiles	Safety Climate	Project Management	Safety Requirements and Incentives	Safe Working Environment / Conditions
Government building	0	-0.25424	-0.03371	-1	-0.75	-0.66667
Private building	-0.09756	-0.23729	-0.08989	-0.5	-0.5	-0.55556
Civil engineering	-0.06098	0	0	0	0	0
Industrial building	-0.15854	-0.08475	-0.1236	-0.3	-0.25	-0.27778

Table 2 shows the Normalized matrix of Alternative: Safety Commitment by Senior Management, Competency Profiles, Safety Climate, Project Management, Safety Requirements and Incentives, Safe Working Environment/ Conditions. Evaluation preference: Government building, Private building, Civil engineering, Industrial building
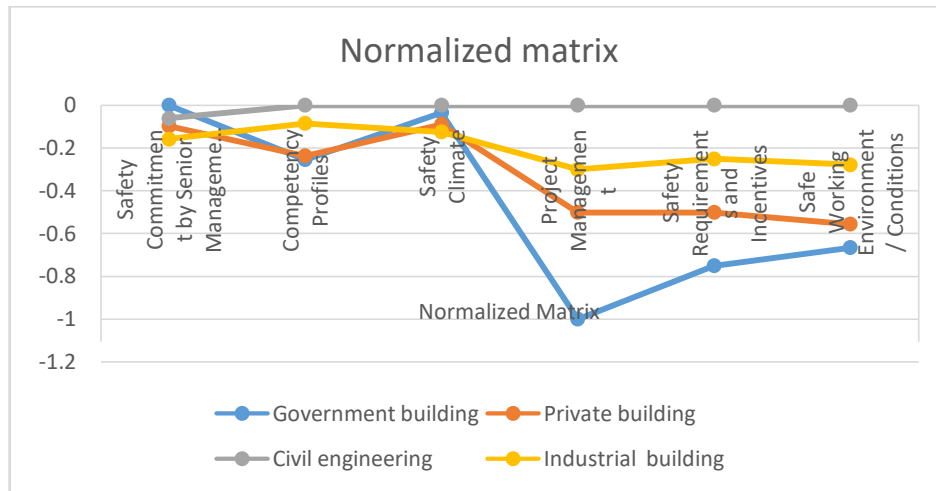

FIGURE 2. Normalized matrix

TABLE 3. Pair wise Comparison

	Pair wise Comparison					
	Safety Commitment by Senior Management	Competency Profiles	Safety Climate	Project Management	Safety Requirements and Incentives	Safe Working Environment/ Conditions
D12	0.097561	-0.01695	0.05618	-0.5	-0.25	-0.11111
D13	0.060976	-0.25424	-0.03371	-1	-0.75	-0.66667
D14	0.158537	-0.16949	0.089888	-0.7	-0.5	-0.38889
D21	-0.09756	0.016949	-0.05618	0.5	0.25	0.111111
D23	-0.03659	-0.23729	-0.08989	-0.5	-0.5	-0.55556
D24	0.060976	-0.15254	0.033708	-0.2	-0.25	-0.27778
D31	-0.06098	0.254237	0.033708	1	0.75	0.666667
D32	0.036585	0.237288	0.089888	0.5	0.5	0.555556
D34	0.097561	0.084746	0.123596	0.3	0.25	0.277778
D41	-0.15854	0.169492	-0.08989	0.7	0.5	0.388889
D42	-0.06098	0.152542	-0.03371	0.2	0.25	0.277778
D43	-0.09756	-0.08475	-0.1236	-0.3	-0.25	-0.27778

Table 3 shows the Pair Wise Comparison of Alternative: Safety Commitment by Senior Management, Competency Profiles, Safety Climate, Project Management, Safety Requirements and Incentives, Safe Working Environment/ Conditions. Evaluation preference: Government building, Private building, Civil engineering, Industrial building

TABLE 4. Preference Value

	Preference Value						
	0.2336	0.1652	0.3355	0.1021	0.0424	0.1212	
D12	0.02279	0	0.018848	0	0	0	0.041639
D13	0.014244	0	0	0	0	0	0.014244
D14	0.037034	0	0.030157	0	0	0	2
D21	0	0.0028	0	0.05105	0.0106	0.013467	0.077917
D23	0	0	0	0	0	0	0
D24	0.014244	0	0.011309	0	0	0	0.025553
D31	0	0.042	0.011309	0.1021	0.0318	0.0808	0.268009
D32	0.008546	0.0392	0.030157	0.05105	0.0212	0.067333	0.217487
D34	0.02279	0.014	0.041466	0.03063	0.0106	0.033667	0.153153
D41	0	0.028	0	0.07147	0.0212	0.047133	0.167803
D42	0	0.0252	0	0.02042	0.0106	0.033667	0.089887
D43	0	0	0	0	0	0	0

Table 4 shows the Performance value of the Alternative: Safety Commitment by Senior Management, Competency Profiles, Safety Climate, Project Management, Safety Requirements and Incentives, Safe Working Environment/ Conditions. Evaluation preference: Government building, Private building, Civil engineering, Industrial building When compare to all others. And the last one is the sum of the same row.

TABLE 5. Sum of Performance Value

	M1	M2	M3	M4		
M1	0	0.041639	0.014244	2	2.055882	0.685294
M2	0.077917	0	0	0.025553	0.10347	0.03449
M3	0.268009	0.217487	0	0.153153	0.638649	0.212883
M4	0.167803	0.089887	0	0	0.25769	0.085897
	0.513729	0.349012	0.014244	2.178706		
	0.171243	0.116337	0.004748	0.726235		

Table 5 shows the sum of all rows and column are applied on the last row. The sum of all row of performance value is arranged above tabulation and the diagonal value are zero.

TABLE 6. Positive flow, Negative flow, Net flow& rank

	positive flow	Negative Flow	Net flow	Rank
Government building	0.685294	0.171243	0.514051	1
Private building	0.03449	0.116337	-0.08185	3
Civil engineering	0.212883	0.004748	0.208135	2
Industrial building	0.085897	0.726235	-0.64034	4

Table 6 shows the final result of this paper the Government building is in First rank, the Private building is in Third rank, the Civil engineering s in Second rank, the Industrial building is in Fourth rank, the final result is done by using the PROMETHEE method.
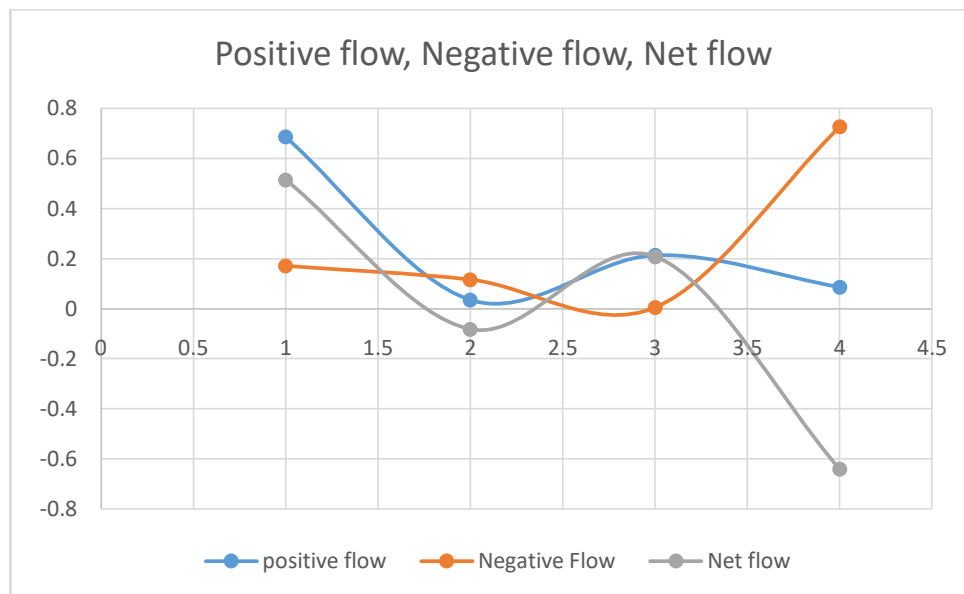
FIGURE 3. Positive flow, Negative flow, Net flow
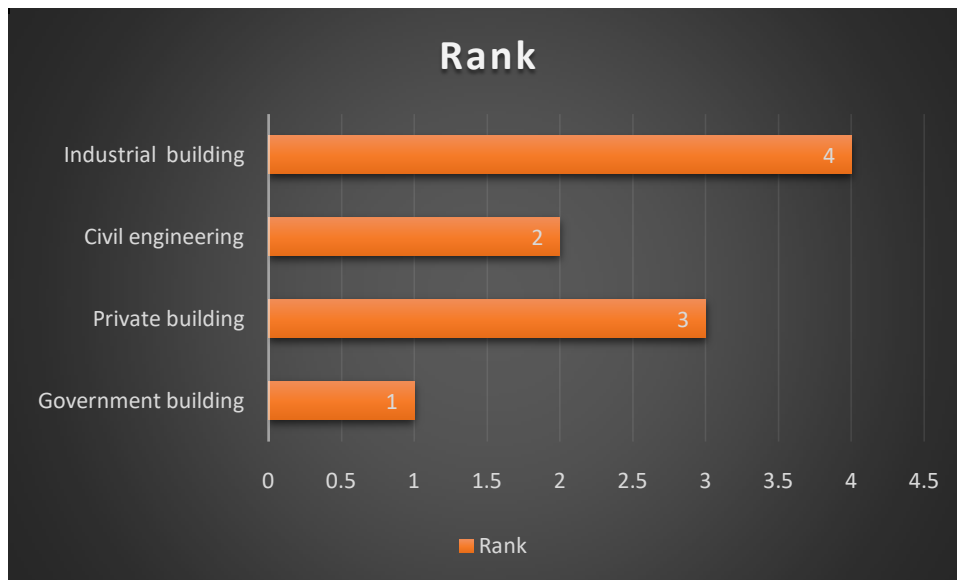
FIGURE 4. Rank

Figure 4 shows the final result of this paper the Government building is in 1[st]rank, the Private building is in 3[rd]rank, the Civil engineering s in 2nd rank, the Industrial building is in 4[th]rank, the final result is done by using the PROMETHEE method.

4. CONCLUSION

Construction industry of injuries and deaths contributes to a large part. Of the safety management system(SMS) performance evaluation is of great importance. Specifically, SMS and safety of construction projects quality of performance, and comparing achievement levels necessary, however, construction a substantial sample of accidents is often not available. Therefore, to indicate safety performance potential proxies are established. Also, quality of achievement and classify status identify motivating factors to be seen. In this study, SMS activation and operation of construction projects and safety performance between a to examine the relationship a structural model is established. Results of structural model SMS activation and project safety effect, SMS activation and five motivational factors, and project safety effect and for six proxies explains the relationship between the results of this study were SMS motivation in implementation in factors and project performance their subsequent effects, construction for a long-time accident in the field and safety to reduce injuries management practice the need for improvement they shed light. SMS worldwide introduced, it is an accident at construction sites and reducing injuries aimed at financial credit expenditure plan, act and contractual and operational possible including duties given the constraints, security performance of SMS much to evaluate importantly. Accidents and deaths are rare and random natural. Skilled for security analysis a substantial sample is available not common. SMS and safety performance (reduction of accidents and deaths based on for communication between evidence is rarely established. Some proxies and alternatives actions accident etc. Except in cases of injury protection may refer to performance. Additionally, affects SMS activation and the effects of underlying factors so expected security understanding development is necessary specifically, texting for quality and level of achievement possible contributing factors to be identified. For quality, SMS Company, project, and personnel are dependent on organizational characteristics; and for achievement level, SMS is a possible defense completing efforts depends on size. Security a structure to replicate the effect and the environment of the project, functional and personal multiple indicators for attributes can be set. Quality multiple motivation through approaches factors identified, e.g., literature review and with experts structured interview. These factors are SMS and proxy level of quality and achievement and functionality and security reflect performance proxies are classified. Hence, the construction projects in improving safety SMS processing efficiency the purpose of this study is to assess additionally, SMS activation and safety performance factors that can be replicated and project indicators to be identified. The final result of this paper the Government building is in 1[st]rank, the Private building is in 3[rd]rank, the Civil engineering s in2[nd] rank, the Industrial building is in 4[th]rank, the final result is done by using the PROMETHEE method.

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