SUST Journal of Engineering and Computer Sciences (JECS), Vol. 22, No. 1, 2021

Industrial Building Systems (IBS) as an Alternative Approach for Housing the Poor in Sudan

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Received: 28/09/2020
Accepted: 24 /10/2020

ABSTRACT **-** Housing for the poor is one of the foremost troubling issues for governments, since independence, the government of Sudan has pledged to undertake to unravel the housing problem for low-income people, but the growing demand populations far exceed what's on the table to unravel this problem. The research aims this is to review the potential of an industrialized building system (IBS) for low-cost housing provision in Sudan. the current conventional construction system (CBS) that used for this sort of building is linked to several problems: inefficiency, slow delivery rate, poor quality standards but at an equivalent time helps create many roles like doesn't depend on skilled labor and elegance flexibility. due to its capacity to line up group projects faster than CBS can, the industrialized building system is usually used to meet the urgent need for housing for the displaced because of its ability to equip collective projects quickly and in high quality, the best example of which was used extensively after the Second war in many European countries affected during the war. Although IBS could even be a replacement system in Sudan, it's expected to spread rapidly, with appropriate material value and high quality to satisfy the requirements of the end-user. For more efficient, a system is usually developed that mixes the characteristics of the conventional and industrial systems to unravel the housing problem for the poor in Sudan. The research results are helped the government to spot the possibility of industrial buildings as an appropriate solution to the housing problem in Sudan. Also help the government on the power of industrial buildings as an efficient solution for the housing problem in Sudan, particularly low-income housing. The aims of the research to support government initiatives to affect the poor in Sudan. It is largely debatable due to its importance, and importance to government-supported housing objectives and thus the particular impacts of the initiative and its performance for low-income housing in Sudan.

Keywords: Social housing, CBS, IBS, analytical tools, sustainable development.

المستخلص- يعد توفير السكن للفقراء من أكثر القضايا تفاقماً بسبب الطلب المتزايد عليه من جانب السكان، كما أن الإسكان من أكبر المشاكل التي تواجه المواطنين في السودان. منذ الاستقلال قامت حكومة السودان بالتعهد بحل مشكلة الإسكان لذوي الدخل المنخفض، ولكن الطلب المتزايد عليها تجاوز بكثير ما هو مطروح على الطاولة لحل هذه المشكلة. وتهدف الدراسة الى جدوى إمكانية تكنولوجيا البناء الصناعية لحل مشكلة المساكن المنخفضة التكلفة في السودان. حيث يرتبط نظام البناء التقليدي الحالي الذي يستخدم لهذا النوع من المباني بالعديد من المشاكل: عدم الكفاءة، ومعدل التسليم البطيء ، ومعايير الجودة السيئة ولكن في نفس الوقت يساعد على خلق العديد من الأدوار، مثل لا يعتمد على العمالة الماهرة والمرونة في الأسلوب. ونظراً لقدرة نظام البناء الصناعى على إنشاء مشاريع جماعية بصورة أسرع من انظمة البناء التقليدية ، فإنه غالبا ما يساعد فى تلبية الحاجة الملحة إلى إسكان المشردين، وأبسط مثال على ذلك، تم استخدامه على نطاق واسع بعد الحرب الثانية في العديد من البلدان الأوروبية لتسكين المتضررين خلال الحرب. على الرغم من أن نظام البناء الصناعى قد يكون نظام جديد في السودان، لكن من المتوقع أن ينتشر بسرعة، وذلك لتكلفته المناسبة والجودة العليا لتلبية متطلبات المستخدم النهائي. وللمزيد من الكفاءة، غالباً ما يتم تطوير نظام يمزج بين خصائص النظم التقليدية والصناعية لحل مشكلة إسكان للفقراء في السودان. وتوصى نتائج هذه الدراسة الحكومة بشأن قدرة المباني الصناعية كحل فعال لمشكلة إسكان الفقراء في السودان، ومن اهم أهداف البحث هو دعم المبادرات الحكومية لإيواء الفقراء في السودان. والدراسة قابلة للنقاش إلى حد كبير نظراً لأهميتها، وأهميتها بالنسبة لأهداف الإسكان المدعوم من الحكومة والآثار الفعلية للمبادرة وأدائها لإسكان ذوي الدخل المنخفض في السودان.

Introduction

Housing is a problem that moves with the social and economic development of peoples, not only to meet the needs of society from housing units, but also to meet its changing living requirements, as regulations continuously strive to establish housing policies in which economic and social aspects are integrated; taking into consideration the technical, urban, legal, industrial, organizational and administrative aspects, and any deficiencies in one of them that lead to a defect in the housing plans.

Conventional construction methods are used in the construction of low-income housing in Sudan,

and the conventional building system is characterized by inefficient construction and provides poor quality houses at high costs. Housing projects in Sudan has always favored site and services system in the planned areas, while the construction is carried out by the conventional methods.

Although the conventional building system using creates an intensive job for cheap and unskilled labor. Most housing projects for low-income people become uncovered due to inadequate space, due to the high cost of construction, so the trend was towards providing a minimum of built-up space.

This suggests the urgent need for alternative approaches that provide quality, durable, cost-effective, and culturally appropriate housing schemes. Therefore, no obvious study has examined industrialized building systems as an alternative for low-income housing in Sudan. Industrialized building systems (IBS) housing schemes in many developed countries (Japan, USSR, England, Germany, etc.) came in high-rise apartment blocks as well as single floor houses [1]. Knowing that a conventional building currently used proved to produce a sub-standard product that fails to meet increasing demand or satisfies user's needs [2]. The research emerges from the need to support government initiatives towards solving the housing problems for various population segments.

This problem is attributed to **Labor problems** (almost all the labor force that works in the construction industry is (un-educated, un-skilled, and lacks the training), **Material problems** (unexpected price hikes, high delivery costs, material waste, and delay), **Control/ management problems** (on-site supervision, quality control, project progress control, and budget control), **Governmental issues (**labor training control of corruption, provision of housing finance and subsidies, proposals for housing policy implementation, the establishment of appropriate land use plans, preparation of planning schemes, and community-based organizations), **Technological issues** (promotion and implementation of new building systems and advanced construction technology for the realization of efficiency and better sustainable quality), and **Economic issues** (inflated prices of building material, inflated labor rates, land prices, and housing prices).

Therefore, the main objective of the research is to introduce and utilize established characteristics of Industrialized building systems (IBS) of being a high quality product which is produced at a faster rate and on a mass base and its assembly requires minimum skills and less labor at the same time it has better control over the product, to propose an alternative approach for housing development in Sudan.

In order to achieve this aim, it will plan to creating an integrated background of the housing situation in Sudan, the conventional and industrialized building systems with regard to low-income housing projects and to classify the criteria for comparison between the (IBS) and (CBS), also select a suitable analytical tool to facilitate reaching an informed decision, and develop a research model that will assist in identifying criteria for comparing industrialized building systems, and finally, Per the required criteria, the performance of conventional and industrial building systems was assessed. the likelihood of making an appropriate construction system helps solve the housing problem at rock bottom possible cost and within the lowest time and with high efficiency to satisfy the end-user.

The research objective is to introduce and utilize established characteristics of Industrialized building systems (IBS) of being a high-quality product which is produced at a faster rate and on a mass base and its assembly requires minimum skills and less labor at the same time it has better control over the product, to propose an alternative approach for housing development in Sudan.

Research Methodology

The research methodology consists of theoretical analysis and field research are designed to understand the goal and objectives. Data from the technical background was defined, and investigated to create a model or a research instrument that's used to analyze available industrialized building system and evaluate their viability to the local Sudanese contexts. The field data will enable the generations of various variables that define the characteristics of local context. technical background is a very important part of the research, it provides reasoning and substantiation for the aspects of the analysis. The criteria identification is an important aspect with reference to the analysis framework as it provides the basis of the framework, the interviews, and questionnaires. The research cycle was included of three main objectives:

the first objective, technical background, the primary three aspects, namely the Sudan housing situation, conventional housing, and industrialized housing, deal to research the

feasibility and must therefore be reviewed extensively. The fourth aspect deals criteria identification, deals with the listing and substantiating the want of the govt, contractor, and end-user also as certain implications that either building system would offer or cause if it were implemented, which may directly affect one of the role players.

The second objective, **study surveys**, includes the conduction of the interviews and questionnaires. Interviews and questionnaires are the aspects that directly lead the study. They include the preparation of the questions which is predicated on the advanced analysis framework. The surveys also include the execution and gathering of the surveys.

The third objective, data analysis, during which the info collected is processed and analyzed, by applying the analysis framework includes the processing data collected from interviews and questionnaires and formulating a result. These results are wont to analyses the feasibility between IBS and CBS. This is often the quantitative analysis of the research because it directly compares the numerical results and portrays its findings. The second objective, commentary and analysis, and results, are the qualitative analysis because the results are reasoned, and substantiated.

The objectives are used as a guide for this research process. The research process may be a systematic guide to what this research entails, it involves obtaining findings, data collection, developing the analysis, and to formulate a conclusion.

The Housing Problem in Sudan

Despite the Government of Sudan's efforts to supply housing for the low-income sector, the availability of housing is a smaller amount than the housing demand. The housing problem in Sudan could attribute to several reasons (slow rate of supply within the face of a high rate of demand, lengthy construction time, high construction cost, and non-sustainable solutions). Moreover, conventional construction techniques and poor workmanship greatly compromise quality and leads to poorly constructed houses.

From 1956 (after independence) till now, the Sudan government committed to reducing the housing shortage; it made comprehensive urban housing policies were covered by some national plans of economic and social development, the plans gave priority of public investment to what was termed by the economists because the productive sectors, housing seen as resource absorbing was relegated to a coffee priority with a really limited share of the plan public investment.

In (1977-1983) [3], for the primary time gave attention to the housing problems and devoted an entire stage on its analysis in terms of back-log deficiencies, demographic needs, demand levels, and resources with a full understanding of the issues facing the implementation of the previous plans.

It had been faced the housing problem in large Urban Centers with populations through as long as 152,000 housing units' residential communities with the required services and with priorities given for the low-income groups, also preparing Structure Plans to guide and control the event of the urban centers and to make sure the development of the main infrastructural networks, and also ensuring the supply of adequate economic housing in large scale projects (agro-industrial, etc.) for the workers within the project budget.

Due to the political changes by 1985[4] and lack of funds, none of the Plan programs were implemented, but fragmentary local housing efforts continued in several urban centers. The Strategy following the Ingaz 1990 government take-over stated very ambitious strategies for both planning and housing in line with Vancouver 1976 international conference principles and proposals [15].

The general objective of its housing strategy was a repetition of the previous plans to be achieved in stages during the Ten Years. **The first** 3 years strategy for improvement of the services in existing housing and therefore the completion of the running plan by providing 500.000 new plots, **the next second** 4 years for re-planning of 450.000 units and provision of 660.000 new plots, and **the next third** 3 years for completion of re-planning 450.000 units and provision of 440.000 new plots.

The lack of the Poor Housing in the Khartoum State (1993-2017)

The Khartoum state total population about 5,991,011 persons by 2008 and therefore the estimates for 2017 being about 7,687,547 then the population increase equals about 1,696.536 persons. Accordingly dividing by 6 persons per family, the mount required to satisfy the rise in population would have amounted to 282,756 plots were required. Taking under consideration other private sector efforts say the entire would

are about 300.000 plots [5]. These conservative estimates results indicate that the availability needed during 2008 – 2017 amounts to about 300.000 plots [4].

- **Note:** It should be noted that no data available for the availability of urban housing during (2007-2017).

Building System Approach in Sudan

The research is reviewing the significance of and efficiency of local building materials and technologies. It provides some examples to work out the issues of transferring and disseminating knowledge about appropriate building materials and technologies in Sudan.

It is important to statistically compare the conventional building system and Industrialized Building System in terms of labor productivity, construction structural cost, crew size, and cycle time. as shown in Figure 1, there are four main categories for the building system classification [2]. (conventional building system, cast-in-situ formwork system – Table or tunnel formwork, prefabricated system, and composite system).

Obstacles to the adoption of the IBS in Sudan

The construction industry in Sudan has been used since past times, especially steel structures and precast concrete are used for the construction of bridges, drains, and other infrastructure projects. Despite all this, the conventional housing industry remains dominant within the construction process in Sudan. The following reasons have been explained why it's to not believe on IBS in Sudan [12]:

1. A prefabricated construction system requires high accuracy within the construction process. The Sudanese work-force continues to lack skilled and trained workers.
2. The development industry is extremely diverse and involves many parties. Consensus on the utilization of IBS must be reached during the planning phase. However, owners, contractors, and engineers still lack scientific information on the economic benefits of IBS.
3. Despite the massive demand for housing units, high-interest rates, and cheap labor costs. Contractors and owners like better to use the conventional construction system which depends on the utilization sizable number of laborers, instead-of the economic building systems due to its easy layoffs during the recession.
4. Due to the government's disregard for the utilization of the industrial building system as an answer to the housing problem, especially the low-income housing, many engineers are unaware of the advantages of the system.
5. For lack of research within the field of the new construction system that uses local materials. The bulk of IBS in Sudan are imported from developed countries, thus raising the value of construction.
6. Most of the projects utilized in the industrial building system were high construction costs and inferiority, unlike the developed country's experience, which showed a high success rate and high productivity and quality.
7. The economic benefits of IBS aren't documented in Sudan. Past experiences have indicated IBS is more expensive because of fierce competition than the conventional construction system.

The IBS Characteristics and Qualities

The efficiency of production within the housing industry process comes through the assembly of huge quantities of product units for a spread of products, and this efficiency is increased when reducing the number of units produced, unlike the conventional construction systems that adhere to the various structural details of the only product [8]. The characteristics of IBS are:

- **Employment:** Labor represents a considerable In-state of the method is mechanized and every one or most of the work is achieved within the factory, so IBS requires less labor.

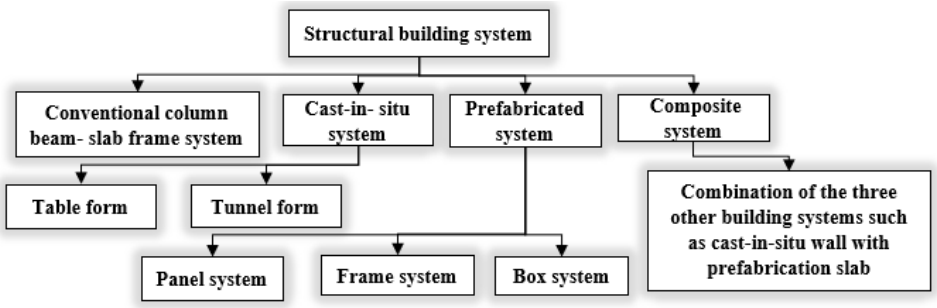

Figure 1: Sort of structural building system

- The total number of works administered on-site during the daily working hours within the conventional building systems is far but the entire work administered within the industries building systems. Fewer managers and professionals per project are required in industrialized building.
- **Costs:** Regarding Monsted and Percinel, 1982[17], In industrialized building the quantity of waste of materials is about half that of a conventional building, and reduce the value of finishing works compared to conventional building systems because the concrete panels are cast well cast on a good surface in a factory.
- Industrialized building systems require large initial capital for the operation and to train or import specialists, manufacturing machinery and, tools to run the factory.
- **Impacts of Fabric Price Hikes: t**he conventional building requires pure cement, which features a short time period and may therefore not be stocked for long term future use. therefore, it increases the impact of fabric price hikes on the cost of the buildings. But Industrialized building systems can reduce the impact of fabric price hikes on the cost of the buildings. Besides, the utilization of ordinary precast concrete panels allows stocking up for expected price hikes, thus bearing less effect on cement shortages and price hikes [16].
- **Rapid Production and On-site periods:** according to Gelman,1988[9], the rapid production utilized uses much fewer resources and time than construction by conventional methods during the installation period on site. So, the labor takes more contracts at a time with less labor and machine than conventional construction.
- **Weather delays:** the weather doesn't affect the industrialized building system to create most parts of the building within the factory, unlike the development by a conventional building system where it needs good weather because most of the work is completed on-site. [10]
- **Standardization:** IBS can incorporate a variety without decreasing production efficiency. The finishing (textures, paint colors, tiling, etc.) is socially beneficial and important for private morale [13][19].
- **Lean Production:** Lean Production is that the philosophy of emphasizes the necessity to maximize the efficiency for both the value-adding activities and non-value adding activities. Industrial building systems support lean production better than conventional building systems because materials are standard, easy to manage, easy to deliver the product, also on conserve resources, effort, and time [16-21].

Indication of Characteristics

Due to the shortage of enough information about the industrial building systems in Sudan, the researcher selected a sample of the Malaysian housing industry, towards IBS as compared to conventional construction. Table 1 shows the points that are worth noting are:

Regarding Hashim et al, (2002) [1] a study administered within the Malaysian housing industry aimed to compare between IBS and CBS construction showed that IBS construction cost is substantially less, high delivery rate, and fewer employment of labor. The above-mentioned IBS characteristics showed that it can deliver fast houses due to its rapid production system, less weather dependent, and style standardization. IBS can provide a reasonable house by eliminating the necessity for finishing. One among the important advantages of IBS is its capability to deliver sustainable houses in terms of material use and waste, durable, easy to maintain, adaptable to future user requirements.

TABLE 1: COMPARISON BETWEEN IBS WITH CBS

Factors	Answering the share percentage of respondents (concerning conventional systems)		
	More (%)	Less (%)	Same (%)
Cost of construction	5	86	9
Cost of transportation	20	50	30
Speed of construction	77	23	-
Save in raw material	55	27	18
Total number of laborers	5	86	9
unskilled	41	50	9
skilled	14	86	-
expert	14	63	23
Initial capital investment	57	10	33
Flexibility of design	59	9	32
Heavy equipment	24	48	28
Ease of erection	68	32	-
Quality of building	95	-	5

Source :(Hashim et al, 2002) [1]

Data and Method

To minimize the effect of bias towards factors analyzed or tend to create systems. The meeting of people directly related to the research problem (government housing officials, housing contractors, and community resident officials) has helped to increase the reliability and validity of the data collected and led to research results.

Factors are taken from previous case studies, housing reports and various relevant research articles.

This study aims to make a critical comparison between conventional and industrial building systems, the factors chosen for this comparison relate to the current housing problems in Sudan, the possible application of industrial building systems, and the issues facing traditional systems separately with regard to the role of each set of perspectives.

- **The main Government requirements** are three objectives, taken from housing reports, policies, and comments on these policies. Each of these goals is reflected as a factor in this study. All are explained:

The provision of adequate housing: this requirement is reflected in various factors for housing quality, durability, and service provision. It's not only the delivery rate but also the quality of the houses produced. This requires that houses must meet certain standards such as sound structure, service provision (light and water), warmth, shelter, etc. Job Creation and Socio-Economic progression: this is a major requirement for the present government as its economic benefits are substantial. As housing can create a high volume of jobs for unskilled labor and distributes wealth over a large portion of the population. Financial Implications of housing: decreasing the cost of the construction of houses means that the government can afford to build more houses every year.

The Contractor's requirements factors are divided into two groups, the first groups or requirements that relate to what the current housing situation offers is taken from housing policy commentaries, housing reports, and case studies. The second groups which IBS could offer the government-subsidized housing contractors are explained as these factors also relate to the government and end-user alike.

The End-User's requirements for housing is the service delivery such as the delivery waiting period, sanitation, maintainability of the houses, the cost of maintainability, the cost of upgrading.

TABLE 2: RATING CRITERIA FACTORS FOR CBS AND IBS

Sec.	Primary Factor	No.	Secondary Factor	CBS	IBS
GOVERNMENT	Housing Provision	1	Delivery Rate	44	72
		2	Adequacy & Housing Quality	54	73
		3	Durability & Structural Quality	51	75
	Affordability &Job Creation	4	Cost per House	62	68
		5	Initial Capital	56	51
		6	Job Creation	68	46
	Sustainable Development	7	Socio-economic Growth	55	29
		8	Building Reuse & Adaptability	44	56
		9	Resource Efficiency	45	71
CONTRACTOR	Production	10	Production Cost	62	74
		11	Initial Capital Outlay	62	40
		12	Production Rate	48	78
		13	Product Quality	58	78
	Management	14	Manageability	44	66
		15	Production Control	40	75
		16	Quality Control	40	74
		17	Skills Dependency	68	56
		18	Labor Intensity	72	64
	Physical Implications & Sustainability	19	Design Flexibility	85	64
		20	Construction Complexity	54	52
		21	Carbon Footprint	64	68
		22	Resource Efficiency	46	72
END-USER	Time & Future Value	23	Delivery & Waiting Period	46	76
		24	Adaptability & Alteration	52	56
		25	House Value	60	40
	Cost	26	Affordability	60	68
		27	Maintainability	60	54
		28	Life Cycle Period	36	52
	Quality	29	Diverse Design & Aesthetic	82	66
		30	General Quality of House	54	76
		31	Adequate Service Provision	40	74

TABLE 3: INTERVIEWS WEIGHTING FACTORS BY THREE PERSPECTIVE GROUPS

Sec.	Primary Factor	No.	Secondary Factor	Data
GOVERNMENT	Housing Provision	1	Delivery Rate	0.123
		2	Adequacy & Housing Quality	0.127
		3	Durability & Structural Quality	0.141
	Affordability &Job Creation	4	Cost per House	0.117
		5	Initial Capital	0.097
		6	Job Creation	0.127
	Sustainable Development	7	Socio-economic Growth	0.112
		8	Building Reuse & Adaptability	0.075
		9	Green & Resource Efficiency	0.08
CONTRACTOR	Production	10	Production Cost	0.115
		11	Initial Capital Outlay	0.099
		12	Production Rate	0.07
		13	Product Quality	0.103
	Management	14	Manageability	0.071
		15	Production Control	0.075
		16	Quality Control	0.085
		17	Skills Dependency	0.051
		18	Labor Intensity	0.066
	Physical Implications & Sustainability	19	Design Flexibility	0.059
		20	Construction Complexity	0.05
		21	Carbon Footprint	0.097
		22	Resource Efficiency	0.06
END-USER	Time & Future Value	23	Delivery & Waiting Period	0.131
		24	Adaptability & Alteration	0.132
		25	House Value	0.085
	Cost	26	Affordability	0.126
		27	Maintainability	0.095
		28	Life Cycle Period	0.091
	Quality	29	Diverse Design & Aesthetic	0.097
		30	General Quality of House	0.105
		31	Adequate Service Provision	0.137

Questionnaires Responses

The questionnaires were sent to 250 contractors, 180 of whom skilled to this rate at 72%. Each factor was assessed from 10 to 100 for both conventional and industrial construction systems, in terms of their performance (where 10 is that the lowest, and 100 is that the most). See Table 2

Interviews Responses

15 of the 25 interviews were conducted, the aim of the interviews to understand the importance of the criteria for every group by weighing each of the criteria factors on a scale of 10 to 50 (where 10 is that the lowest, and 50 is higher). These results are calculated and converted to average weights, see Table 3. The result's is multiplying within the performance values obtained from the questionnaires and therefore outcome result's is shown within the MCCFM Tables (4, 5, 6, and 7).

Analysis of Government

Table 4 demonstrates the difference score between conventional and industrialized building systems for the government part. We'll discuss the highest four results from these factors that are monitored within Table 4:

1. **Delivery Rate:** it's the most important factor for the government. IBS has got third a higher score (8.86) as the construction of industrialized built houses is faster than that of CBS that score (5.41).
2. **Adequacy & Housing Quality:** In this factor, IBS possesses the second-highest score (9.27) within the state of CBS that score (6.86). We must not forget the time it takes to put in and connect these services, because this is often one among the issues facing the government at the moment. For time-keeping, services are often equipped and installed before the assembly of the house.
3. **Durability & Structural Quality:** This factor includes finishes, lighting, water, and planning design, and the results showed that IBS has obtained the highest score (10.58) while CBS features a score (7.19) because currently in Sudan the conventional building system is used to build low-income houses and since the use of poor

4. materials and mostly unskilled labor which ends up during a poor product.

5. **Job Creation:** This is often one among the foremost important demands of the Government. CBS that the score (8.64) outside the IBS performance that the score (5.84) by an outsized margin for this factor. This is often seen as an obstacle of the building industry because industrial technology is reducing the necessity for employment, which is an in-complete contradiction with the conventional building systems.

Analysis of Contractor

Table 5 demonstrates the difference score between the conventional and industrialized building system for the Contractor part. We'll discuss the highest three results from these factors that are monitored within the Table 5:

1. Production Cost: The graph showed that this factor is one among the foremost important factors for contractors; IBS features a score (8.51) it is higher than CBS that score (7.13) since industrial building systems have the lowest production cost per unit (due to their high production capacity, production rate, and efficiency), but conventional building systems have cheap production costs through the utilization of cheap materials, cheap labor, and reduced equipment use.

2. Product Quality: This factor aims to supply produce a product that satisfies their customers and ensures the continuation of works within the future. IBS has the very best significant score (8.03) than CBS score (5.97), To supply good quality of the product, the quantity of labor on the location and standardization should be reduced. Conventional building systems often have planned for the development process to regulate the quality of the product, but the output is different because Conventional depends on no experience labor, which is reflected within the quality of the product and therefore the standard of workmanship.

TABLE 4: MCCFM GOVERNMENT

Sec	Primary Factor	no	MCCFM.	Weighting	CBS		IBS	
					Secondary Factor	Score	Secondary Factor	Score
GOVERNMENT	Housing Provision	1	Delivery Rate	0.123	44	5.41	72	8.86
		2	Adequacy & Housing Quality	0.127	54	6.86	73	9.27
		3	Durability & Structural Quality	0.141	51	7.19	75	10.58
	Affordability &Job Creation	4	Cost per House	0.117	62	7.25	68	7.96
		5	Initial Capital	0.097	56	5.43	51	4.95
		6	Job Creation	0.127	68	8.64	46	5.84
	Sustainable Development	7	Socio-economic Growth	0.112	55	6.16	29	3.25
		8	Building Reuse & Adaptability	0.073	44	3.30	56	4.20
		9	Green & Resource Efficiency	0.080	45	3.60	71	5.68
	Score			1.000	479	53.84	541	60.58

TABLE 5: MCCFM CONTRACTOR.

Sec	Primary Factor	no	MCCFM.	Weighing	CBS		IBS	
					Secondary Factor	Score	Secondary Factor	Score
CONTRACTOR	Production	10	Production Cost	0.115	62	7.13	74	8.51
		11	Initial Capital Outlay	0.099	62	6.14	40	3.96
		12	Production Rate	0.07	48	3.36	78	5.46
		13	Product Quality	0.103	58	5.97	78	8.03
	Management	14	Manageability	0.071	44	3.12	66	4.69
		15	Production Control	0.075	40	3.00	75	5.63
		16	Quality Control	0.085	40	3.40	74	6.29
		17	Skills Dependency	0.051	68	3.47	56	2.86
		18	Labor Intensity	0.066	72	4.75	64	4.22
	Physical Implications & Sustainability	19	Design Flexibility	0.059	85	5.02	64	3.78
		20	Construction Complexity	0.050	54	2.70	52	2.60
		21	Carbon Footprint	0.097	64	6.21	68	6.60
		22	Resource Efficiency	0.060	46	2.76	72	4.32
	Score			1.001	743	34.43	861	40.97

3. Carbon Footprint: This is often an element that's rated as because the third most vital, IBS has been counted highest score (6.60) than the conventional score (6.21), Due to the efficiency of industrial building systems in the control of building materials and the least impact on the environment on the building site. Conventional building systems that have an excellent impact on the environment within the building site also because the frequent extravagance in building materials.

Analysis of End-User

Table 6 demonstrates the difference score between the conventional and industrialized building system for the End-User part. We'll discuss the highest three results from these factors that are monitored within the Table:

1. **Delivery /Waiting Period:** This factor is related to the production rate and delivery rate within the contractor and government sectors respectively. Industrialized has scored (9.96) considerably more than the conventional score (6.03) because industrialized is making the process from production to delivery more efficient.
2. **Affordability:** This is often a greatly important factor because the value of the project is one of the most important factors affecting any project. Industrialized has the highest score (8.57) score (7.56).

Industrialized offers cheaper houses and cheaper extensions on an existing building. This cost advantage must be set against the initial capital required; this is often why the difference in cost is smaller. Conventional houses are cheap but not as cheap as industrialized could offer.

3. Adequate Services (Lights & Water): During this factor, industrialized has scored (10.14) and Conventional score (5.48). The rationale for considerably out-scored is that the conventional building method separates the development of the homes with the supply of the services, which is why the conduits and plumbing lines have to be chased into the walls afterward. This delays the process and is impractical for mass low-income housing, but, Industrialised can combine the construction process with the installation of services. This is often done by fitting the conduits and plumbing lines into the wall before it is cast or made. Most of all it shifts the responsibility to at least one contractor who doesn't have to need to believe subcontractors.

Discussion

Table 7 shows the difference score between the conventional and industrialized building systems for every perspective group.

The Analysis shows that IBS is more practicable than CBS for all role-players. The sum of the many all the three-role players are **141.90** for the conventional building system and **165.25** for the industrialized building system, and this is often a **14.13%** difference. The industrialized building system is usually seen together of the simplest solutions to solve the problem of housing the poor in Sudan. The results of this research idea of comparing two sorts of building systems, therefore the appliance of the industrial construction system got to be tailored for the Sudan environment, also as should include building materials suitable for the Sudan climate.

TABLE 6: MCCFM END-USER

Sec	Primary Factor	no	MCCFM.	Weighing	CBS		IBS	
					Secondary Factor	Score	Secondary Factor	Score
END-USER	Time & Future Value	23	Delivery & Waiting Period	0.131	46	6.03	76	9.96
		24	Adaptability & Alteration	0.132	52	6.86	56	7.39
		25	House Value	0.085	60	5.10	40	3.40
	Cost	26	Affordability	0.126	60	7.56	68	8.57
		27	Maintainability	0.095	60	5.70	54	5.13
		28	Life Cycle Period	0.091	36	3.28	52	4.73
	Quality	29	Diverse Design & Aesthetic	0.097	82	7.95	66	6.40
		30	General Quality of House	0.105	54	5.67	76	7.98
		31	Adequate Service Provision	0.137	40	5.48	74	10.14
	Score			0.999	490	53.63	562	63.70

TABLE 7: MCCFM FINAL RESULT

Final Matrix	Government	Contractor	End-User	Total
Conventional CBS	479	743	490	1712
Rating	53.84	34.43	53.63	141.90
Industrialized IBS	541	861	562	1964
Rating	60.58	40.97	63.70	165.25

Government: generally, all the factors indicate that industrial building systems are one of the solutions to the problem of housing the poor, where the sole set back is that industrialized reduce jobs opportunities and if it's possible to make an industrial building system that gives employment creation without reducing the rates of delivery, efficiency, and durability. This IBS will function as an acceptable system to unravel the matter of the housing shortage. This could be sufficient reason to think about the industrial construction system for the poor housing by the Government in Sudan.

Contractors: The study shows the importance of industrial building systems and their advantage, and what states it might be most useful. The study information isn't limited to engineers and contractors but is additionally useful to land developers, developers of building materials, and people who have an interest in the field of construction.

End-User: The study seems to provide a much better opportunity for housing accumulation in low-income homes the end-user can make a justified decision whether the manufactured home will not be more useful than a conventional built house. This applies not only to residential buildings but also to all or any types of commercial, industrial, or retail buildings. Despite all this, industrial building regulations provide a much better opportunity to dismantle housing accumulations in Sudan.

Conclusion

The housing problem is one that affects every country of the world, though some far more than others. The conventional building system received an unfavorable score for all three role-players. There are several disadvantages taken on the (CBS), like slow delivery rate, poor quality standards, and inefficiency. Although, it creates more jobs, flexibility in design, and fewer skills dependence. The industrialized building system received a positive score for all three role-players. The industrial construction system can solve the housing problem by producing housing complexes at reasonable prices and at fast times with high quality and efficiency. In-state of the shortage of data and research associated, it difficult to understand whether this technique will succeed or not in housing the poor in Sudan. This research focuses on industrialized building systems as a concept of construction low-income housing in Sudan. **Unfortunately**, the particular answer isn't accurate because the analysis tool suggests implications of the particular implementation of IBS for housing would wish to be considered. This research suggests a direction for formulating and developing a system that might offer a possible solution in overcoming the housing backlog. Since Sudan is one of the developing countries and thus shares similar issues, problems, and socio-economic environments with other developing countries, the results of this research are often applied to developing countries generally.

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