

TOWARDS IMPLEMENTATION OF INDUSTRIALIZED BUILDING SYSTEMS IN SYRIA'S URBAN RECONSTRUCTION

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ABSTRACT

Today there is a high need to put a spot light on industrialized building systems, IBS for an effective use in Syria's priority urban reconstruction phase. The traditional construction methods are project-oriented, and this causes fragmentation and in addition to the low productivity. Therefore, the development of the Syrian construction sector towards adopting IBS process will make changes in the structure and management of the construction process in the reconstruction phase; and this the main aim of the paper, which presented a review for literatures related to industrialized building systems, features of industrial processes, as well as a description of the Syrian construction sector and its features prior the war and now, review some related studies, also the main challenges, strengths and weaknesses, opportunities and threats towards adopting IBS in Syria. In addition to that, the study presented a proposed roadmap in towards successful implementation of IBS in the phase of Syria's reconstruction. Finally, the conclusion focused on the development of this research, and presented recommendations for future research work. The research findings will benefit both of the stakeholders in Syrian government and private sectors in fulfilling the requirements for heading towards IBS in the reconstruction phase.

KEYWORDS: Industrialized building systems (IBS), Industrialization, Construction industry (CI), Syria, Reconstruction, Roadmap, Prefabrication.

1. INTRODUCTION

The Syrian construction sector faces an essential challenge in order to transfer the current construction practices toward a modern and dynamic industry. Therefore, the reconstruction phase should transfer the Syrian construction sector to a new level; by changing it to become an industrial, developed and modernistic sector rather than being a traditional sector without industrial processes.

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The main problem is that the traditional construction methods are project-oriented, and this causes fragmentation and absence of the process continuance in addition to the low productivity. So it will be impossible to provide the required number of new buildings - which will be huge due to the shortage before the war and now due to the great destruction as a result of the war - relying on traditional building methods for build a very big number of the required buildings, in less time, and an appropriate cost and quality, especially in the difficult circumstances caused by the war. Accordingly, IBS can be presumed as a main key and a priority to solve this problem in the reconstruction and rebuilding phase.

The research framework consists of three parts. The first part outlines the characteristics, features, and concepts related to IBS. The second part describes through a literature review the Syrian construction situation before the war and now, to determine the most important guidelines that we must use in developing guidelines for IBS roadmap. The third part will include measures and policy regulations for the steps for implementing IBS process and propose a strategic road map towards an effective implementation of IBS in the reconstruction of Syria.

The present research assumes that the “Urban Reconstruction” proposals will be implemented after securing peace and ending war conditions. As it is possible that the collected data and the administration of the “reconstruction” responsibilities, and related actions and procedures during this aspired to “peace” phase, be completely different (from the present times) to suit the new conditions and development objectives in Syria.

2. AIMS AND OBJECTIVES OF THE STUDY

The aims of this paper are:

- 1) Learning or knowing about IBS context and its features, types and concepts.
- 2) Identifying obstacles and factors that would hinder successful implementation of IBS adopting.
- 3) Propose a strategic roadmap towards successful implementation of IBS in Syria’s priority urban reconstruction.

3. METHODOLOGY OF THE STUDY

The descriptive methodology was used in this study, where data related to IBS were collected, and described, then analyzed its characteristics and features. An analysis of the Syrian construction sector was presented, in terms of the requirements and difficulties that facing the application of IBS.

4. SIGNIFICANCE OF THE STUDY

The significance of the study to construction is, it can reduce the usage of conventional methods, and increase the level of awareness toward adopting IBS in the reconstruction of Syria. Where the implementation of the IBS can make changing in the construction industry, CI, raise the quality and productivity of the construction sector and speed up the process of Syria to achieve reconstruction efficiently.

5. THEORETICAL FRAMEWORK: DEFINITIONS AND CONCEPTS

In the next sections we will discuss the scope of relevant concepts with industrialized building systems, there present definitions, concepts and categories.

5.1 Industrialized Building Systems Definitions and Concepts

Industrialisation is used in different contexts; construction sector is one of them [1]. In its general meaning, industrialization expresses about any prefabrication. However, today researchers submitted industrialization as a process and/ or technique as well [2]. In addition industrialization depends on its high ability for reducing the costs, improving the quality and make complex products available for a wide majority scope of users [3]. But with construction sector the situation is completely different from most other kind of industrialized products, because the buildings could never be accomplished totally at the factory as it is related to the site. Consequently, the final products are not complete buildings but Industrialized Building Systems IBS [4].

Besides, the modernization of production methods in the field of industrialization led to changes in the organizational and technological processes used and in social relations, where the work organize become centralized and automate production procedures to meet mass production principle [5].

Furthermore a building system is defined as “all work components necessary for a particular type of building together with their execution techniques and procedures, while providing stability and stability” [6, 7].

The usage of mechanization techniques in construction which carry out to the production of the IBS may help relieve the pressures of labour requirements while increasing productivity and quality [8]. There is a various definitions to the Industrial Building Systems IBS according to the different scope of industrialization degrees, as mentioned in Table 1 below.

Table 1. Selected definitions in industrialization and IBS.

	Definitions
Industrialization	Is a strategy: a large market will amortize a process capable of simplifying the production, thereby reducing the efforts and costs that required to produce each unit while assuring quality [4].
	Description of all forms of pre-construction work like prefabrication or modularization and pre-assembly, which means relatively complete and fully automated project processes [9].
IBS	A construction technique with minimal operating work in site, where all the components are manufactured in supervised conditions both on-site or off-site, then are transported, placed and assembled into a building structure [2, 10, 11, 12]
	All the building parts like slab, beam, column, wall and staircase which produced in mass quantities either in plant or at site accompanied by strict control on quality and decrease wet works in site to minimum [9, 13, 14].
	A construction process which uses construction methods, components, products or techniques that include prefabricated elements and on-site assembly [13, 15].

All the definitions have emphasised on mass production, prefabrication, assembly, standardized components and design using modular coordination and off-site production, as the essential characteristics of IBS [13, 16].

5.2 Classification and Types of IBS

The IBS are categorized into many classifications; however each building system (defined by the static behavior of receiving and distributing loads throughout the different building components) can be classified to three main systems which they are: bearing wall, skeleton, and spatial system. Also, based on the geometrical configuration, IBS can be classified according to its structural systematic aspects to these three parts, as the following [17]:

- Linear units or frames (beam and column) or one-dimensional units.
- The Panel units or two-dimensional units.
- The Rectangular or Boxes units or three-dimensional units.

Based on the fact that building is technology factory related and site related, there are three basic categories of IBS which they are [4]:

- The Site-Intensive Kit-of-Parts: The sub-systems are made at specialized plants and delivered separately to be assembled at the site.
- The Factory-Made 3D Module: The building is divided into volumetric modules assembled at the plant and connected to the infrastructure and between them-selves once at the site.
- The Hybrid: Producing at the plant the complex parts of the building and entrusting the site with the heavy or simple operations.

The first two categories represent the two extremes whereas the third category is reaching for the best of both worlds [4]. In addition to that, there are two main types of IBS, which they are the ‘closed’ and ‘open’ systems [12, 14].

Nowadays in Syria, due to the needed for mass production, increase in quality and shorten the construct time [3], industrialization of construction become an important issue to the Syrian construction sector, where the common construction method can be classified in accordance to their own construction technology as shown in Fig. 1.

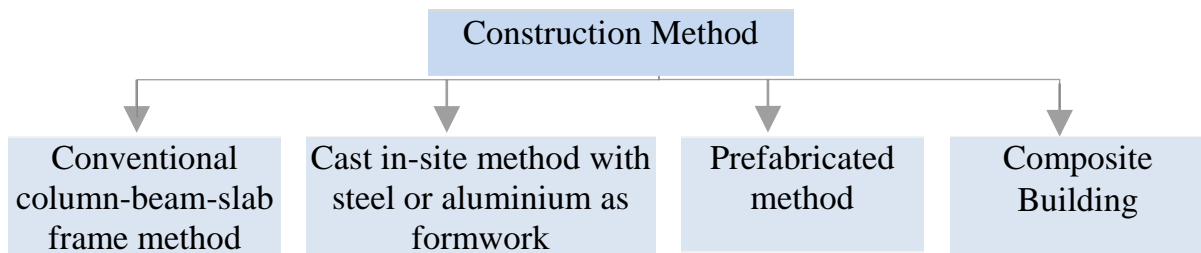


Fig. 1. Type of construction method in Syria.

5.3 Concepts in Building Industrialization

There are many concepts and terms in the scope of building industrialization that became related to because of the rapid progresses of IBS together with various

meanings and definitions. All common construction methods can be divided according to the industrialization degree into a general classification as the following [2, 3]:

- Semi-industrial methods
- Industrial methods
- Advanced degrees methods (or optimized construction)

It is possible to present a modern trend for industrialization consists of five levels or degrees, which clarify in Fig. 2 [3]. The first four items require a great primary capital for production facilities. However, it is capable to transfer the works from human force to machine and increase traditional production process. The fifth degree which is re-production, aim to production simplification, and indicates to research and development of renovation process [3].

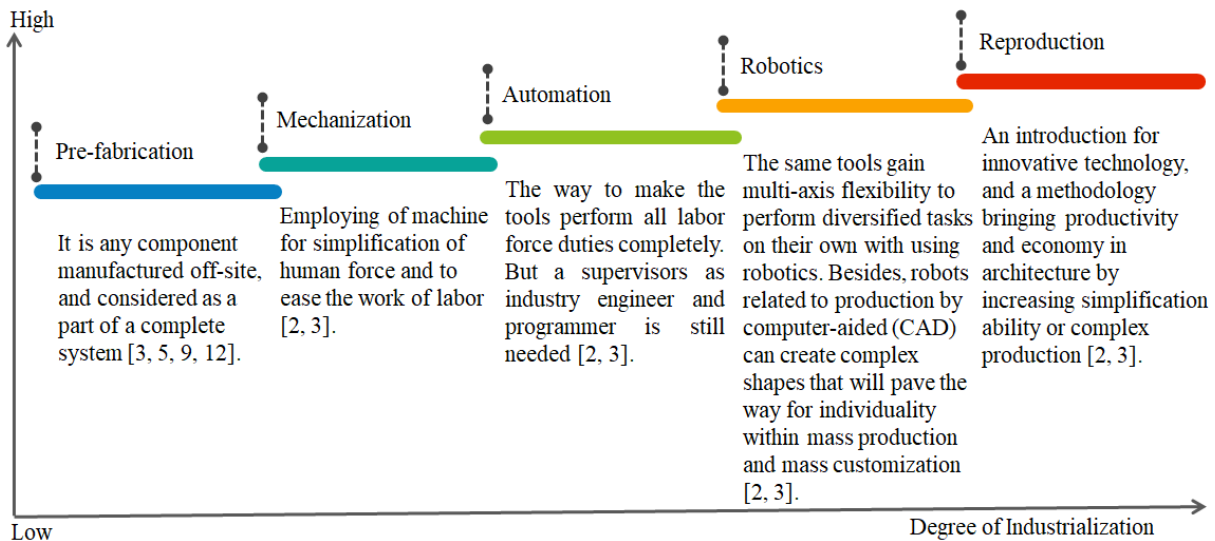


Fig. 2. Degrees of industrialization.

5.4 The Features of Industrialization Building System

The prime features of an IBS are that many of the building components are prefabricated offsite at a central facility, where the successful industrialization process need prerequisites features, that can be summarize in centralization of production, mass production, standardization, specialization, good organization and integration. All of operations of the design, production, and onsite erection must be planned and coordinated as an integrated process because they are highly interrelated [6, 17]. Where the usage of modern construction technology adds to buildings new value for

investment in buildings [18], in addition to its ability to address and integrate sustainable features, dynamic responses and aesthetic options to the user and the environment at the same time [19].

5.5 Sustainable Industrialized Building Systems (SIBS)

The industrialization of construction is important due to increase in quality, reduce the cost, mass production and etc, but the contemporary IBS should focus on sustainability as a new comprehensive trend. IBS has a lot of characteristics in accordance with sustainability, so IBS can achieve the goals of sustainable construction relying on harmonizing with environment, increase quality, good design and planning, more flexibility and optimization [8]. The Sustainable Industrialized Building Systems SIBS as a new trend consider the economic, technical and environmental issues of somehow. In general, the features of SIBS are connected with four basic objectives in technical, economic, social and environmental groups and these four objectives include enhancing the quality, increase flexibility through good planning and building optimization, enhancing economic savings and the finance, increasing the usefulness and social efficiency and increasing the compatibility with environment and reducing the impact on environment [2, 20].

5.6 The Nature of Construction Industry in Syria

This section provide a background for the Syrian construction sector

5.6.1 Syrian construction sector features prior to the current situation

This sector considers as a service industry for other sectors, and its products vary and spread all over Syria. It is characterized by the real estate companies and large number of the employees [21]. Nevertheless, the CI suffers from inefficiency and poor performance in comparison with region countries [22]. And before the current situation, it has many features, the most important of them:

- The public sector is obsolete but dominating the private one, which is seen as dispersed and simple [21, 23].

- Lack of training and qualification programs for practitioners in the construction profession in addition to the weak quality control system [21].
- The lack of awareness for the importance of adopting new technologies to keep pace with technological development in engineering and the failure of educational institutions to adopt and spread these technologies widely [22].
- Lack of adequate and accurate databases related to the construction sector [24].
- The construction methods varied between traditional and modern methods, but till these days, construction as an industry is still highly dependent on manual labor, unskilled labor and construction on site [25].
- Construction policies and practices systematically lacked both appropriate strategies and evolving methods of change [26].
- Limited financing mechanisms and high interest rates, in addition to the high cost of obtaining a residence [25].

5.6.2 Syrian construction sector in the current situation:

Relevant studies was review in order to assess the reality of the construction sector, compare it with the concepts and characteristics of the IBS, determine the status of Syrian position with regard to these concepts, as well as evaluate the factors that affect on CI, to use that for the proposal roadmap of reconstruction phase. The studies have shown that the trend towards the modern CI faces great challenges despite the imperative of that as a strategic decision in finding solutions to the crises of housing and reconstruction, as the majority of new buildings still using the traditional methods in construction [27], despite the fact that the advanced technology method (Pre-Cast Concrete) was one of the most advanced methods used in CI. In general, the construction sector shows a significant decrease in application of most factors that affecting the CI [28]. On the economic level, there is a notable decrease in controlling construction time, and on the human resources level, there is a decrease in both general safety and workers safety, and training or education. Also for the infrastructure, the factories and supporting mechanisms for the CI and the specialized technological

means of transportation both of them are low application availability, and similarly for the technical aspects [27].

In addition, a review of the Syrian experience in the field of evaluating some indicators performance (time, quality, cost) indicates the low level of these indicators, and this evaluation accompanied by the challenges of the scarcity of the local studies which searching in the field of implement the modern technologies and their relationship to the design and construction [27].

However, limitations can be attributed to two levels a strategic and operational. Construction policies and building practices are systematically lacking appropriate strategies and evolving methods of change. Consequently, a comprehensive process is required to adjust the policies, principles and strategies of the government intervention to enhance cooperation between the public and private sectors [26]. The lack of a comprehensive and systematic database, where the data are often not geographically comprehensive and delayed so that does not allow to monitor developments, nor allow for rapid intervention in emergency situations, in addition to the difference between the sources of this data [29]. All of that requires the utilization of any available capabilities and the concerted efforts of the various stakeholders and addressing the challenges that hinder their participation, whether they are financial, legal, spatial or administrative challenges, and strengthening its role as an effective sector [25]. And requires developing the products of public sector factories "materials or technologies" and using them to raise the efficiency and speed of implementing the work of CI [25]. On the other hand, other researchers determined that the use of partial manufacturing technology is considered feasible for Syria and developing countries, as it is one degree higher in the ladder of technological complexity than the traditional practice, and thus it is easier to accept and use [30]. Hence, we need a lot of development in the Syrian construction sector and raise the level of the construction methods in use, to meet the current needs, and this is what this study brought to complement the previous studies, and propose a roadmap towards effective implementation of IBS in the reconstruction phase.

5.6.3 The challenges of construction industry in Syria

Cost, time and quality are the primary issues that should motivate Syrian construction sector to adopt IBS in reconstruction works [9], but implementing it may faces numerous challenges.

A review of current Syrian data led to the establishment of five main issues. These issues related to IBS, site, construction workers, project team, and local authorities [21].

On other hand with respect to monetary issues, IBS is a system which is efficient in both in term of time and quality, however, it is cost consuming and in most cases about 50% of the costs have to be covered in advance. These challenges, in addition to the implication associated from these challenges, may come from various sources, and definitely have an impact on project success thus, all conditions and situations should be well managed to avoid any risk and towards ensuring success in projects [21].

5.7 Strength, Weakness, Opportunity and Threat in Adopting IBS in Syria

The IBS construction can be evaluated, and to achieve the desired goal of arriving at an integrated roadmap towards effective implementation of IBS based on scientific research and technological development, it is necessary to analyze the current reality of the Syrian construction sector, to enhance its strengths, overcome its weaknesses, know the opportunities available to invest and turn them into strengths and find the appropriate solutions for the risks they face, Table 2 present this analysis.

6. IMPLEMENTATION OF IBS IN SYRIA

Nowadays, the Syrian construction sector is aware of how the technological developments in both manufacturing and industry is important to develop a CI capable to drive the reconstruction phase, where the benefits of implementation IBS are considerable and wide-ranging, such as reducing construction cost and time, reduce wastage and improve site management, and that can to contribute efficiently in the reconstruction, and will eventually produce better products for the people.

Table 2. Strength, weakness, opportunity and threat in adopting IBS [21, 24].

Strength	Weakness
<ul style="list-style-type: none"> - Reduce labor needs and unskilled workers - Improve productivity and quality of Syrian construction sector - Safer working environment in construction site - Reduce cost and project duration - Positive impact on supply chain problems - Freedom from restricted weather conditions, especially Syrian winter - Effective resource utilization and energy consumption in reconstruction phase 	<ul style="list-style-type: none"> - Site constraints, scope and increased transportation considerations. - Requires a high initial investment capital in Syrian construction sector. - Increased engineering requirements. - Coordination and communication. - Training of unskilled and semi-skilled labourers. - Monopolise the market by the contractors and manufacturers. - The deterioration of the status of many companies and factories which producing building and construction materials.
Opportunity	Threats
<ul style="list-style-type: none"> - The possibility of investment in IBS, as a result of that, new job opportunities and thereby stimulating other productive sectors. - Investing in IBS will achieve a sophisticated CI. - Providing added value to local building and construction materials, revitalizing human resources and raise the workers skills. - The ability to attract major international companies specialized in building and construction, and benefit from their expertise. - Attract reliable global technologies and advanced methods for implementing various projects. - The possibility of re-building the destroyed areas in a modern way. - The presence of young human capital, able to keep pace with scientific and technological progress related to IBS. 	<ul style="list-style-type: none"> - The actual conviction of the role of science, technology and innovation in advancing the current reality and thus providing support to adopt IBS is not embodied. - Migration of competencies and the skilled workers are seeking to migrate abroad. - Slow pace in the steps of economic and administrative reform and the absence of overall strategies. - Resisting change, and not responding to the proposed scientific initiatives which call for the adoption of modern technologies. - The private sector is not motivated to invest in scientific research or adopts building industry techniques. - Lack of coordination between the relevant authorities. - Inability to access modern and advanced technologies. - The investment in this sector is linked to the security and political situation.

6.1 Roadmap Towards Successful Implementation of IBS in Syria

The Syrian government must establish a roadmap to implement IBS, in purpose to provide guidelines to establish an industrialized construction sector in Syria, along with adopts the increasingly rapid technological changes. If that occurred, IBS is anticipated to have a great role in guarantee improvement in construction practices and contribute to sustainable economic growth in reconstruction phase.

To support the Syrian construction sector and to prove that the research is an instrument for CI transformation to meet the reconstruction demands, the following implementation phases for IBS roadmap were suggested and summarized in Table 3. The main drivers are reduction in waste, increase in productivity, reduction in accidents, reduction in construction time, and increase in predictability.

Table 3. Roadmap of implementation IBS in Syria.

Start Action	Description	Target
Measures and policy regulations for adopting IBS	<ul style="list-style-type: none"> ▪ The first step: Studying the Syrian current situation of the construction ▪ The second step: Strategic planning for modular coordination implementation ▪ The third step: Preparation the Syrian Standard (SS) guide to Modular Coordination in Building ▪ The fourth step: Execution the modular coordination through legislation 	To enable the IBS to be standardized through modular coordination
Strategic thrusts	<ol style="list-style-type: none"> 1. Enhancing the professionalism of the CI. 2. Endorsing an integrated approach to construction. 3. Improving practices and techniques of CI. 4. Raising the level of skills. 	To impose high level intended outcomes of accomplishment IBS
Pillars of the roadmap	<ol style="list-style-type: none"> 1. Reducing the total costs. 2. A Good designs. 3. Time efficiency. 4. The ability to do buildings successfully and efficiently. 	To keep concentration, it can consider as a policy objectives and key performance indicators
Action plan courses	<ol style="list-style-type: none"> 1. The first course of action: Government institutional Strengthening. 2. The second course of action: Focusing on User. 3. The third course of action: Product Focus. 4. The fourth course of action: Industry Focus 	To achieve the roadmap pillars

Table 3. Roadmap of implementation IBS in Syria, (Cont.).

Set of Actions that address the key drivers		Off-Site Manufacturing	On-Site Mechanization and Automation	
Products/Services/Technology	Short	Design for efficient manufacture / off site construction / pre-fabrication	Standardised construction processes and components	Mass Adoption & Application of Off-Site Manufacturing, Automation & Mechanization Processes & Methods
	Medium	Efficient off-site manufacturing and pre-assembly	Completely digitised sites	
	Long	automated design, factory production, and modular assembly	On-site robotic assembly and improved site working conditions	
Research Enablers		<ul style="list-style-type: none"> • Adaptation of new concepts developed by other manufacturing industries • Research materials to simplify, reduce cost, improve quality, etc. for automated off-site fabrication and on site erection • Produce construction automation guidelines • Investigate rationalisation of construction processes, with focus on off-site assembly of large, fully-fitted components • Research the automation of construction plant & equipment • Research process orchestration e.g. flow of resources for optimal build efficiency. • Investigate the use of integrated data models to facilitate modularisation 		Intelligent assets enablers, to enable the development of these products, services and technology

Since the priority is the urban reconstruction, the roadmap propose that the appropriate timing for reconstruction; will be after securing peace and stabilization; taking into consideration the factors, determinants and procedures that may arise when implementing reconstruction.

The first phase: It is important to Syrian Government to suggest measures and policy to facilitate adoption of IBS. Therefore the process of enforcement of policy regulations should enable the IBS to be standardized through modular coordination, where the uniform Building by Law is very important for a successful implementation of modular coordination in the industrialized building program.

The second phase: Where the policy main aim is to impose high level intended outcomes of accomplishment IBS. Therefore, the Syrian's construction should identifying the strategic thrusts requirement for the CI in reconstruction phase.

The third phase: The roadmap should focus on adoption of IBS in both public and private sectors. To keep concentration, it can be abbreviate to four policy objectives, and they are: cost, quality, time and competence which they are the main pillars of the roadmap.

The fourth phase: To achieve the roadmap pillars, the Syrian government should establish an action plan, based on courses of action, each course of action consist of a set of actions drawn from its current reality.

The fifth phase: Provides a set of actions, which schedules out the technologies, products and services that were identified by the CI to address the key drivers.

The sixth phase: The research and enablers have been identified, in order to deliver the technologies products and services (divided into short, medium and long-term activities).

6.2 Monitoring And Evaluation

(M and E) helps participants to implement the roadmap to assess progress that is in line with expectations in the plan, where they monitors and evaluates the performance in the roadmap implementation, and this is supposed to be led by the Syrian government. In this regard, it is required to conduct a self-assessment of performance according to specific time periods and provide evidence of compliance to the M&E unit. In addition to conducting a self-evaluation of performance and finally be responsible for preparing reports and conducting performance measurements.

6.2.1 Setting performance targets

All concerned units will define their performance objectives in a schedule form, at the beginning of the year for example, along with set timelines as part of their annual work plans and in a way derived from the IBS roadmap implementation.

6.2.2 Performance monitoring

Monitoring involves developing indicators; Establish systems to collect information related to these indicators; then collecting and recording the information and then analyzing them; finally, use the information to inform responsible authority day-to-day for all new information. The main reasons of monitoring can be summarized as follows:

- To determine whether performance targets have been achieved and provide necessary explanations.
- Act as an early warning system to detect potential difficulties and help address them during the roadmap implementation.
- To provide feedback for the next stage of implementation, reducing costs and increasing the efficiency of post-evaluation studies.

6.2.3 Performance evaluation

Performance evaluated shall be executed quarterly and annually, for example, and the agreed performance indicators and targets at all levels will be used to measure this assessment. The result of the annual evaluation will form the basis for the next year's plan or interim plans, and thus will update the roadmap plan.

7. CONCLUSIONS

The adoption of IBS in the Syrian construction sector is very important, given its features and benefits that fit the urban reconstruction phase. Where the reality of construction suffers from many problems and is still not ready to adopt modern technology, in addition to the general lack of research efforts to spread the use of or evaluate applications for IBS; this was demonstrated through the use of the descriptive methodology that studied the reality, presented the information and analyzed it, until reaching to a proposal roadmap to help achieve the successful implementation of IBS in the reconstruction of Syria.

Accordingly, the research concluded the following results:

- 1) The use of IBS ensures valuable advantages such as reducing unskilled labor, reducing waste, reducing waste building materials, increasing environmental

- hygiene, organizing and making construction site safer, improving quality control and reducing construction completion time.
- 2) The CI plays a critical role in the government's efforts to stimulate domestic economic activities and boost growth. It is therefore important for the sector to take measures to increase efficiency, quality and productivity, and to this end, the use of Industrial Building Systems IBS is the right step in achieving this goal.
 - 3) The literature review indicated the lack of research efforts related to the use of potential applications for IBS in Syria and its shortage adoption in the projects.
 - 4) The CI in Syria faces major challenges, as its current levels of quality, productivity, reliance on unskilled workers and lack of funding and safety, not in line with the demands of the reconstruction phase.
 - 5) The CI needs a single basic plan that includes all the important aspects of this development process. So, this roadmap was proposed as a reference for all parties in implementing all programs for modernizing the Syrian construction sector.
 - 6) To embed recommendations into a practical tool, this research used the SWOT analysis format, and the derived findings were used to establish the roadmap SWOT guidelines for Improving IBS applications , where the SWOT analysis helped identify the motives for using IBS, and identify the strengths points to enhance it and overcome the weakness, by developing the strategic directions and pillars of the roadmap, and thus identifying opportunities for investment in IBS and transforming them into a set of procedures that address the main drivers and suggest measures to enable this.
 - 7) Despite some restrictions related to the collection of current reality data and the limited access to resources related to the construction policy in Syria, the study has successfully created a roadmap of implementation IBS in Syria based on collecting and analyzing information in order to define the scope, and to realize the long-term vision of the CI, as the priority area IBS was defined through: the widespread application of the processes and techniques of off-site manufacturing, mechanization and automation.

8. RECOMMENDATIONS

The following recommendations are suggested to ensure the adoption of this roadmap and its integration into the Syrian construction sector, and to conduct related future research:

- 1) The Syrian government should accelerate the take-up, adoption and development of IBS technologies and encourage contractors and architects to do so, through training, monetary aid, and identification of gaps or strengths, which is an activity that must be undertaken as part of the "implementation" phase of the roadmap.
- 2) The roadmap is the key section of this paper, and should be reviewed and updated periodically to ensure longevity and relevance to the new changes, especially that the roadmap suggest that the appropriate time for reconstruction is after securing peace and stabilization; where the factors, determinants and procedures maybe will be different when implementing "reconstruction".
- 3) Future research could consider transforming parts of the IBS Roadmap into a computerized tool to more analyze and address drivers, limitations and application approaches, and develop a knowledge management system for information exchange on previous projects of IBS to provide decision tools to key stakeholders at various stages of construction.
- 4) Consideration should be given to the end-users of IBS or building occupants, so future research could further investigate in how the IBS buildings improve the health and safety of occupants or livelihoods, and thus activities may need to be redefined or inclusion new proposals on how to address the IBS Roadmap.
- 5) Research is recommended, considering that "urban reconstruction" is a priority, to conduct more studies after the situation in Syria has stabilized, and to collect the necessary data from the relevant administrative and technical authorities, if available, as it will be important to manage the "reconstruction" procedures.

DECLARATION OF CONFLICT OF INTERESTS

The authors have declared no conflict of interests.

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نحو تنفيذ أنظمة صناعة البناء في إعادة الإعمار الحضري في سورية

هنالك اليوم حاجة ماسة في سورية لإلقاء الضوء على أنظمة صناعة البناء IBS، من أجل الاستخدام الفعال لها في مرحلة إعادة الإعمار الحضري ذات الأولوية في سورية. إن طرق البناء التقليدية موجهة نحو المشروع بعينه، وهذا يؤدي إلى التجزؤ وغياب الاستمرارية، بالإضافة إلى أنها تتصف بانخفاض الإنتاجية. لذلك، فإن تطوير قطاع التشييد السوري نحو عملية تبني IBS، ستؤدي إلى تغييرات في هيكل وإدارة عملية البناء في مرحلة إعادة الإعمار؛ وهذا هو الهدف الرئيسي من هذه الورقة البحثية، التي قدمت مراجعة للقراءات المتعلقة بأنظمة صناعة البناء، خصائص ومفاهيم العمليات الصناعية المتعلقة بها، وكذلك وصف لقطاع البناء والتشييد السوري وأهم خصائصه قبل الحرب والآن، واستعرضت بعض الدراسات ذات الصلة، أيضاً عرضت التحديات الرئيسية، نقاط القوة والضعف وكذلك الفرص والتهديدات تجاه تبني IBS في سورية. بالإضافة إلى ذلك، قدمت الدراسة خارطة طريق مقترحة نحو التنفيذ الناجح لـ IBS في مرحلة إعادة إعمار سورية. وأخيراً، ركزت الخاتمة على تطوير هذا البحث وقدمت توصيات للعمل البحثي المستقبلي. حيث ستفيد نتائج هذا البحث كلاً من المعنيين في الحكومة السورية والقطاع الخاص في تلبية متطلبات التوجه نحو IBS في مرحلة إعادة الإعمار.