Gearing sustainable construction in Lebanon : role of inferential stakeholders

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Abstract

This Ph.D thesis falls under the field of Management of Information Systems and Environmental Sustainability and answers pressing needs raised by local and global environmental concerns and the overarching global commitment of countries to the United Nations 17 Sustainable Development Goals. In particular the thesis addresses the scope of SDG 11 on Sustainable cities and communities which is even more pressing and urgent in the Mediterranean environments.
Lebanon is a small, mostly mountainous country situated on the eastern Mediterranean coast, which is suffering from a large number of the problems characterizing countries around the Mediterranean basin and in particular unplanned urban sprawl and irreversible destruction of natural ecosystems over a narrow and limited geographical space

This thesis ambitions to gearing sustainable construction in Lebanon through understanding the challenges hindering the shifting to sustainable construction building on a multiproxy approach mixing Geographical Information Systems, Social Network Analysis, purposely sampled interviews of Semi structured and unstructured types.

While attempting to evaluate the viability of the concept of Smart Cities for Lebanon as a way towards sustainable cities, the research has contributed to highlighting that Lebanon, in its current state, is not ready to implement the Smart city concept essentially due to limited available infrastructure, and the absence of vision from the Government leading to the realization of Smart Cities moreover the limited/absence of resources dedicated for such a shift (Fenianos et al, 2018).

The thesis has explored the possibility to rely on Green Buildings as a viable pathway towards sustainable construction in Lebanon and has consequently confirmed that International Green Rating Systems not only exist in Lebanon but are implemented and recommended; Lebanon has developed a National GRS that is adapted to existing commercial buildings but is not available for residential nor new buildings. The Geographic Information System analysis has confirmed that existing green buildings are still timid and scattered across the Lebanese territory. This timid adoption of GRS in Lebanon is probably due to lack of awareness of GRS as alternatives to conventional construction projects; High initial investment requirement posing a challenge for small and medium developers; complex bureaucratic process as the government is still in a brick-

and-mortar phase. This resulted in a noticeable cost benefit deficit where the cost of upscaling a building to green can not materialize financially (Fenianos et al., 2020).

Finally, the research enables understanding on what aspects can inferential stakeholders influence the adoption of sustainable construction in Lebanon. The analysis of the construction process has enabled confirming the pivotal importance of the initiation phase in gearing construction towards green and sustainable constructions. The Social Network Analysis constructed showed the direct and indirect networks existing in a conventional and green construction, confirming that the go and forth between administrative/ technical processes leading to green construction is complex. The cross functional activities prevalent in green construction requires conscientious project management as inferential stakeholders' expectations are intertwined and strongly interconnected.

As recommendations the research states that in order to enact change there is a need to scale the adoption of green rating systems not only to primary stakeholders but to secondary as well. Change can be set through voluntary or through involuntary means. Starting with voluntary, creating a need for green buildings in Lebanon should pass through various hierarchical avenues in order for change to be realized. Starting with financial and taxation incentives tracking the upper echelon, by backing entrepreneurial ventures driving towards wider adoption by levying the financial risk. Second, buyers should be made aware of the potential advantages of owning a green building as the premium initial cost of purchase will be offset by the high efficiency and effectiveness of resources utilized. Involuntary can be through enacting smart cities through government legislation

Due to the high frequency of directive nodes and its multifaceted portfolio of receivers, the Order of Engineers and Architects(OEA) plays an essential role as an inferential stakeholder in gearing towards sustainable construction. Encompassing them in awareness raising programs and educational support to universities and fresh graduates. The OEA can play a fundamental role in advocating for new governmental regulations and imposing higher environmental standards for syndicate members, on another note the OEA can incentivize its affiliates to shift from conventional construction to sustainable one via increased quota, reduced permit costs as an

example. The role of the OEA is indispensable and the findings stress on endorsing a new role as a sustainability change agent.

Keywords

Sustainability, Environmental Sustainability, Management Information Systems , Stakeholder Management , Actor Network Theory , Smart Cities, Green Building , Green Rating System, Social Network Analysis

Extended Abstract in French

La durabilité est l'état dans lequel les conditions de développement et d'exploitation/usage des ressources continuent de répondre aux besoins des sociétés sans pour autant menacer « l'intégrité, la stabilité ainsi que la beauté » des milieux biophysiques. Le terme de « durabilité » doit ainsi être considéré comme l'objectif majeur/cible de l'humanité en matière de développement et de respect des équilibres sociétés et écosystèmes. Partant de ce principe, le programme de développement durable à l'horizon 2030, adopté par la totalité des membres des nations unies en 2015, synthétise cette notion à travers 17 objectifs à atteindre, les ODD (Objectifs de Développement Durable).
Parmi ces objectifs, l'ODD 11 concernant les défis des villes et des communautés durables, attire de plus en plus l'attention du monde entier. La croissance urbaine, le développement des grandes métropoles ainsi que la croissance démographique, entraînent une croissance sans précédent en matière de construction. Ces infrastructures sont cependant la cause de plusieurs problèmes environnementaux durant toutes les étapes de leur cycle de vie (construction, fonctionnement, maintenance et destruction). Les bâtiments sont alors énergivores et consomment de grandes quantités de ressources, ce qui a un impact sur le changement climatique du fait des répercussions sur la qualité de l'air et de l'eau dans les villes.

Atténuer l'impact des bâtiments sur le changement climatique est cependant un objectif réalisable à partir de concepts « d'architecture durable » ou de « bâtiments verts ».
Comprendre les défis auxquels le Liban doit répondre afin d'accomplir la transition à la construction durable, représente une entreprise colossale.

La crise économique qui touche le pays a sévèrement impacté le PIB dont les estimations de croissance ne sont que de 0,2% et 0,6% pour 2016 et 2017 respectivement.
Au Liban, peu d'études ont été réalisées afin d'enquêter sur les problèmes rencontrés par le secteur de la construction. Cette recherche a pour objectifs de mettre en avant dans les projets de construction au Liban, les principales activités ainsi que les inférences des parties prenantes lors de la phase de pré-construction. *À partir de l'analyse des réseaux sociaux, des différences, au*

sein d'un projet de construction, concernant l'implication, les préoccupations et l'importance des contributions des parties prenantes, est illustré.

Dans un projet de construction, l'analyse des parties prenantes peut représenter un intérêt concret pour les chefs de projet ainsi qu'un réel bon en efficacité dans la gestion des équipes et la communication avec les parties prenantes. Cette analyse est peut-être plus facilement applicable à la gestion des parties prenantes externes. Enfin, l'établissement d'un plan de communication du projet est également un résultat pertinent de cette analyse. Cela aidera l'équipe à définir et comprendre avec quelles parties prenante elle doit communiquer et comment. Dans le cadre de grands projets, ceci permet de définir clairement les voies de communication et d'assurer la cohérence.

Cette thèse a pour objectif de comprendre comment les parties prenantes dans un projet de construction, contribuent à la réalisation de l'ODD 11 sur les villes durables dans le contexte libanais, celui d'un pays méditerranéen en développement complexe. Elle a également pour but d'examiner les défis qui entravent au Liban, la transition vers le construction durable dans le cadre du développement durable de ses villes.

- Est-ce qu'une Ville Intelligente est une solution viable pour répondre aux problèmes de pression urbaine et donc ainsi de tendre positivement vers la durabilité au Liban ? *Les limites de la recherche sur les villes intelligentes sont abordées.*
- Est-ce que les bâtiments vers/systèmes de notation vert (GRS), sont une solution viable pour la durabilité au Liban ? Recherches et limites.
- Comment peut-on influencer/guider ? Définition du rôle des parties prenantes.

La recherche se structure autour du secteur de la construction considérée comme un pilier majeur de l'économie et responsable de pressions considérables sur l'environnement. Ce secteur représente de ce fait un fort potentiel en matière d'influence et d'orientation vers la durabilité au Liban. Synthétisant la complexité et les difficultés/défis rencontrées par la plupart des pays du pourtour méditerranéen, le Liban projette ainsi les défis du secteur de la construction pour sa transition vers la durabilité.

Le second chapitre fourni le cadre théorique de cette recherche en examinant les liens entre la théorie de l'acteur-réseau (ANT), la théorie des parties prenantes et la construction durable. Dans ce chapitre il est aussi question d'affirmer que l'application de la perspective des parties prenantes aux théories du système d'information sur la création de valeurs, peut contribuer à la réalisation des objectifs de développement durable. L'application du point de vue des parties prenantes aux théories des systèmes d'information sur la création de valeur peut permettre la réalisation des ODD. Les types de réseaux existant entre les acteurs humains et non humains dans un projet de construction aura un impact sur les acteurs dans la mutation vers la construction durable. Rassembler ces théories fournira un moyen de compréhension majeur sur la façon dont l'implication et les apports des parties prenantes augmentent.

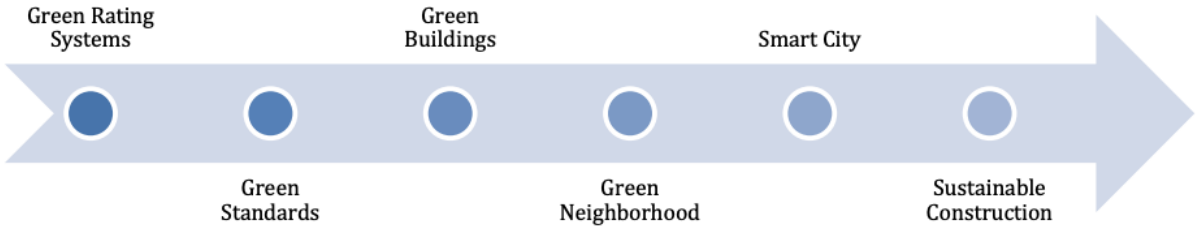
La construction est un projet complexe qui implique une diversité de réseaux entre les parties prenantes du projet ou bien à travers des activités de liaisons et des jalons. Cette thèse les aborde à travers la théorie de l'acteur-réseau qui intègre une description des acteurs selon un réseau de nature humaine et non-humaine, comme le suggère Latour/tel qu'exprimé par Latour.
Les études sur la théorie de l'acteur-réseau fournissent des synthèses/comptes rendus détaillés sur la façon dont les acteurs humains et non-humains forment progressivement des réseaux d'acteurs stables. Cependant en raison de l'attention portée sur un contexte de recherche particulier, il existe peu d'orientations génériques sur la manière dont les acteurs les plus pertinents peuvent être identifiés lorsque le contexte de recherche évolue. Les principes comportementales/du comportement des parties prenantes (humaines) présentés dans cette thèse dirige/guide l'identification des parties prenantes humaines à travers un processus itératifs, interprétatif, dynamique et contextuel, montrant comment ils peuvent être adoptés et étendus pour inclure également l'identification acteurs non-humain. Ainsi nous soutenons qu'ils peuvent jouer un rôle déterminant en fournissant des conseils génériques décontextualisés pour l'identification des parties prenantes, ce qui fait actuellement défaut dans les études sur la théorie de l'acteur-réseau (ANT).

Les réseaux d'acteurs humains est exprimé dans l'ANT mais a évolué à partir de la théorie des parties prenantes de Freeman qui implique l'identification, l'analyse et la gestion. Ainsi, en analysant les parties prenantes et en comprenant leurs interactions et leurs relations, nous

pouvons identifier les lacunes potentielles à exploiter dans la promotion des bâtiments durables au lieu/par rapport aux bâtiments conventionnels et donc, de mettre en œuvre leurs pouvoirs et impacts pour la transition aux constructions durables.

Le troisième chapitre aura pour objectif de présenter le cade méthodologique de la recherche, le choix des méthodes employées avec leurs limites seront donc exposés. Les données seront principalement collectées selon une approche multivariée de personnes-ressources comprenant des entretient en face à face, des entretiens semi-structuré, des entretiens par téléphone ou par e-mails non structurés. Ce chapitre détaillera également les activités de collecte de données, les instruments, les profils des personnes répondant à l'enquête ainsi que les résultats de l'objectif de recherche.
La stratégie/le type d'échantillonnage choisi pour toutes les phases de recherche est l'échantillonnage non aléatoire (échantillonnage raisonné). Les répondants/personnes-ressources ont quant à eux été sélectionnés en fonction de leur poste et expérience professionnel, leurs connaissances de base/culture générale et de la catégorie de partie prenante dans laquelle ils s'inscrivent. La taille de l'échantillon était de ce fait réduite mais du fait que celle-ci est en adéquation pour ce type d'étude, cela n'invalide en rien les résultats de la recherche. En effet, l'étude se base sur des analyses de réseaux sociaux ainsi que d'autres formats, mieux adaptés à des techniques d'analyse dans lesquelles l'échantillonnage statistique ne conditionne pas le traitement de données, contrairement aux méthodes plus traditionnelles d'analyses qualitatives.

Explications/Détails sur comment et pourquoi ces outils ont été mis en œuvre et la manière dont ils s'inscrivent dans le contexte de la recherche :



Ces outils examinent le concept d'une ville intelligente (*smart city*) qui place au centre des stratégies, la gouvernance et l'implication des parties prenantes. Le Liban est sous-performant/accumule des lacunes, sur plusieurs fronts, augmentant les difficultés dans la mise en place/l'établissement de villes intelligentes. En effet, la mise en place de villes intelligentes nécessite d'importantes préparations en termes de politiques, de plan et programmes nationaux. Le Liban n'a pour l'instant formulé aucune stratégie viable pour répondre aux composantes essentielles des villes intelligentes.
L'analyse réalisée nous a conduit à explorer la préparation du Liban par rapport à ce concept de ville intelligente. Un cadre exploratoire a été conçu afin d'aborder les potentielles mutations vers des quartiers verts qui encourageraient le Liban à davantage s'orienter vers des alternatives vertes/respectueuses de l'environnement.
Une revue des différents systèmes d'évaluation écologiques aux échelles nationales et internationales employés, auxquels se conforme divers projets de constructions au Liban, de la construction conventionnelle au processus de construction plus respectueuses de l'environnement/écologique/vertes. Il est question pour le projet d'afficher les divers activités et tâches à travers la structure de répartition du travail. Celle-ci traite, entreprend et souligne les différences ainsi que les points de mutations/changements possibles. Ainsi, la compréhension de l'importance de la phase de pré-construction dans le processus de construction est mis en avant car celle-ci présente également les plus grands avantages économiques.

Dans le chapitre 5, les résultats ont été déduit à partir de la cartographie et de la classification des parties prenantes les plus pertinentes dans la formulation d'une vision de la ville intelligente.

Les résultats ont également été déduit de l'analyse des rôles et relations de ces parties prenantes. Cette recherche a exploré l'état de l'art au Liban concernant le contexte des bâtiments verts/écologiques. La revue MTO s'est intéressée/penchée sur l'état de préparation du Liban à la transition vers les villes intelligentes. Les résultats montrent que le rôle du gouvernement, en tant que médiateur et investisseur dans cette entreprise, n'est pas rempli, ce qui participe à augmenter les difficultés au Liban pour la transition des villes intelligentes.

Le chapitre 6 a pour objet les points de basculement/de transition dans les projets de construction conventionnelle la faisant passer à une construction respectueuse de l'environnement. Plusieurs initiatives ont été développés sous le concept de la ville intelligente afin de pouvoir répondre aux défis que rencontrent les villes actuellement. Le concept a évolué, partant d'une approche basé sur le secteur à une vision plus compréhensive/complète qui place la gouvernance et l'implication des parties prenantes au cœur des stratégies urbaines. Le chemin qui mène à la construction durable est différent en raison des caractéristiques des environnements externes et internes que nous sommes en train de traiter. Il n'y a pas de solutions générales pour chacun des défis, chaque problème est traité selon son contexte environnemental. Les parties prenantes sont des décideurs qui doivent être pris en considération lors des processus de mutations.

Pour comprendre les défis de la transition à la construction durable au Liban, ce travail s'est concentré sur le concept de la ville intelligente en explorant la possibilité de s'appuyer sur des bâtiments respectueux de l'environnement (bâtiments verts) dans les futurs projets de constructions. Comprendre quels aspects les parties prenantes dans ces projets peuvent influencer dans l'adoption de construction durables au Liban.
Les résultats indiquent un manque de vision gouvernemental capable de diriger, une faible prise de conscience parmi les parties prenantes capables d'orienter une mutation vers les villes intelligentes au Liban et essentiellement, la limitation/l'absence de ressources nécessaires pour une telle transition. Les résultats ont été communiqués à la communauté international par le biais d'une communication orale (LAAS, Fenianos et al., 2018) ainsi que d'un article publié dans une revue à comité de lecture (Fenianos et O'Brien, 2020).

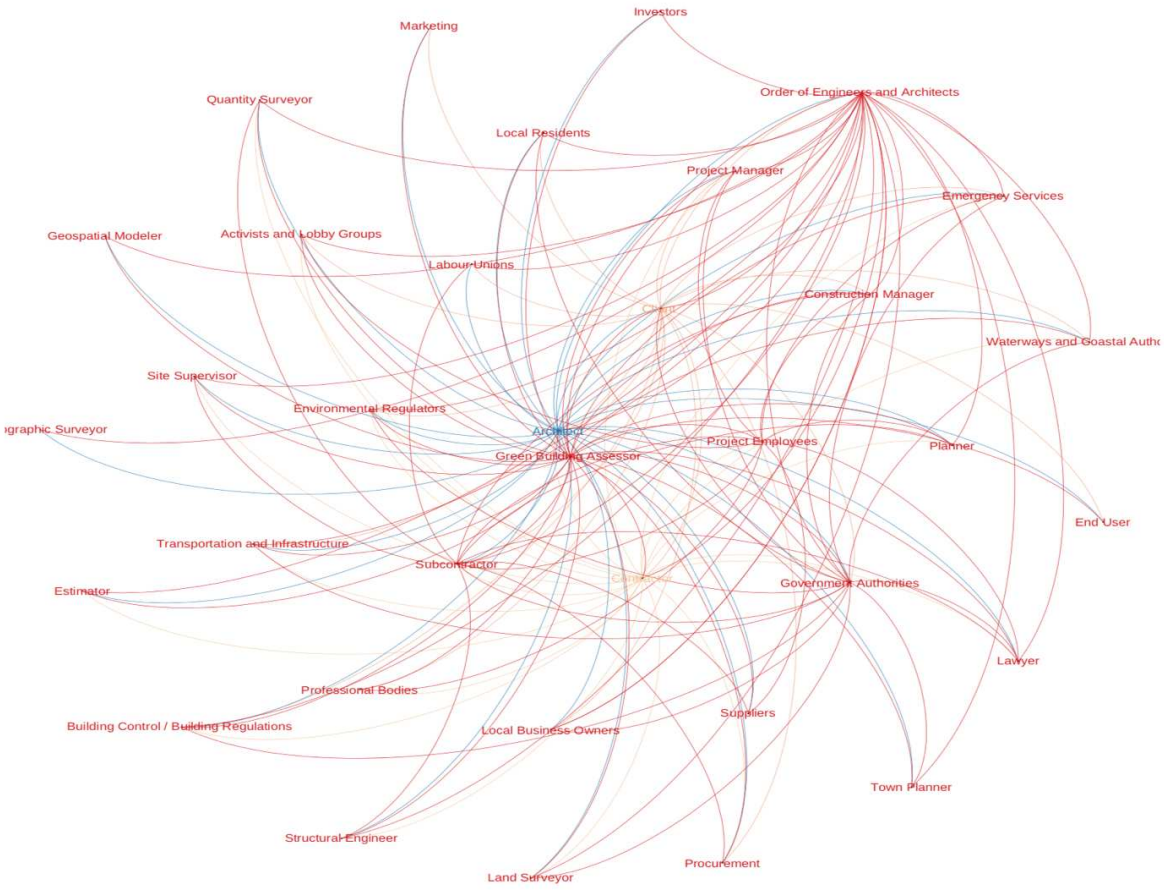
Cette thèse explore l'état de l'art au Liban traitant des bâtiments verts/respectueux de l'environnement. Les système de notations verts (*Green Rating Systems – GRS*) internationaux ont été les plus employés tandis qu'à l'échelle nationale un système de notation verts a été timidement entrepris : le système Libanais de notation verts – ARZ.

Plusieurs problèmes ont été rencontrées lors des entretiens oraux ainsi que dans les revues d'articles scientifiques en raison du fait que les données ont été basées sur des entretiens. Le manque de ressource nécessaire pour approfondir l'analyse représente une limite qui a empêché

l'usage de méthodes quantitatives de triangulation. De surcroît, ce manque d'approfondissement a grandement limité la portée de l'analyse du fait qu'aucune recherche d'approches alternative aboutissant à la construction durable n'a pu être entreprises.

L'analyse menée a confirmé que les bâtiments respectueux de l'environnement existant au Liban sont en faible effectif et très éparpillés sur l'ensemble du territoire. Le Liban a développé un système national de notation verts (ARZ) adapté aux bâtiments commerciaux déjà en place mais aucun système de notation n'est conçu pour les bâtiments résidentiels ou pour les nouvelles constructions. De plus, le manque de sensibilisation des clients, des architectes et des ingénieurs, qui représentent les parties prenantes centrales dans le secteur de la construction, est un facteur qui explique ce faible nombre de bâtiments respectueux de l'environnement observé au Liban. Les parties prenantes doivent être sensibilisées aux avantages des alternatives respectueuses de l'environnement par rapports aux approches plus conventionnelles en construction. Cette transition doit pouvoir s'appuyer sur des incitations financières et non financières ciblant les investisseurs, les clients ainsi que les promoteurs, dans le processus de construction et en facilitant les achats à un stade ultérieur.
L'analyse des réseaux sociaux a pu mettre en évidence les réseaux directs et indirects existant dans la construction conventionnelle et écologique, confirmant que la coexistence des processus administratifs/techniques qui mènent à une construction respectueuse de l'environnement est complexe. Les activités interfonctionnelles prévalent dans la construction respectueuse de l'environnement nécessitent une gestion de projet consciencieuse en raison du fait que les attentes des parties prenantes concernées se croisent et sont fortement interconnectées.

En conclusion de l'analyse, nous identifions trois défis de la gestion des relations avec parties prenantes afin de tendre vers la construction durable : le renforcement des intérêts des parties prenantes dans une approche de construction durable ; la création d'intérêts mutuels en matière de durabilité et, sur cette base, donner aux parties prenantes les moyens d'agir afin que celles-ci puissent remplir leur rôle d'intermédiaires au sein de projets de développement durable. Pour répondre à ces défis, trois mécanismes interdépendants sont proposés pour les parties prenantes : l'éducation, la réglementation et la création de valeurs basées sur la durabilité.



L'ordre des ingénieurs et architectes (OEA) libanais a joué un rôle central dans la promotion des bâtiments respectueux de l'environnement par le biais de programmes de sensibilisation et de support éducatifs aux universités et jeunes diplômés. L'OEA peut jouer également un rôle fondamental en plaidant pour la mise en place de nouvelles réglementations gouvernementales et en imposant des normes environnementales plus strictes aux membres du syndicat.

Les analyses du processus de construction ont confirmé l'importance de la phase de pré-construction dans la transition du secteur à la construction durable. Les bâtiments respectueux de l'environnement au Liban doivent passer par différentes voies hiérarchiques afin que le changement/la mutation, puisse se réaliser. Des incitations financières et fiscales pouvant conduire à l'assouplissement des obstacles financiers barrières monétaires pourraient encourager une adoption plus étendue d'un modèle de construction respectueux de l'environnement. De plus, les clients doivent pouvoir être informés des avantages économiques potentiels pouvant

outrepasser le coût initial élevé de l'achat d'un bien immobilier respectueux de l'environnement. En effet, ce coût peut être compensé par une meilleure gestion des ressources utilisées.
L'OEA peut par exemple, également inciter ses membres à adopter le modèle de construction durable en augmentant les quotas et en réduisant les coûts des permis de construction.

Contents

The following table describes the significance of various abbreviations and acronyms used in the thesis:

Abbreviation	Meaning
ANT	Actor Network Theory
BDL	Central Bank of Lebanon
BRE	Building Research Establishment
BREEAM	Building Research Establishment Environmental Assessment Method
BRS	Building Rating System
DGUP	Director General of Urban Planning
FDI	Foreign Direct Investment
GB	Green Building
GBRS	Green Building Rating System
GDP	Gross Domestic Product
GIS	Geographic Information System
GRS	Green Rating Systems
ICT	Information and Communication Technologies
IFC	International Finance Corporation
IMF	International Monetary Fund
IS	Information Systems
IT	Information Technology
LCEC	Lebanese Center for Energy Conservations
LEEA	Lebanese Environmental Action
LEED	Leadership in Energy and Environmental Design
LGBC	Lebanese Green Building Council
MDG	Millennium Development Goals
MOE	Ministry of Environment
MTO	Management Des Technologies Organisationnelles
NEEAP	national energy efficiency action plan
NEEREA	National Energy Efficiency and Renewable Energy Action
NGO	Non-Governmental Organization
NREAP	national renewable energy action plan
OEA	Order of Engineers and Architects
PMI	Project Management Institute
PPES	Policy paper for the electricity sector
SC	Smart City
SDG	Sustainable Development Goals
SNA	Social Network Analysis
ST	Stakeholder Theory
SWOT	Strength Weakness Opportunity Threat
UN	United Nations
UNDP	United Nations Development Program
WB	World Bank

General Introduction

The 2030 Agenda for Sustainable Development, adopted by all United Nations Member States in 2015, summarizes its goals under the 17 Sustainable Development Goals (SDGs), which are an urgent call for action by all countries. The 17 goals are divided into 169 targets that seek to build on the Millennium Development Goals and complete what they did not achieve (https://sdgs.un.org/goals). These goals incorporate a wide array of objectives culminating in sustainable production patterns, the use of natural resources, and aiding sustainable development through targeting, sustained inclusive economic growth, social development, and environmental protection (United Nations, 2020).

Understanding these relationships requires wider and deeper interdisciplinary collaborations. Climate change and sustainable development governance are better connected than ever to maximize the effectiveness of action in both domains. The emergence of new coordinating institutions and sustainable development planning worldwide represents promising progress. From carbon pricing to green industrial policy, economic ideas have shaped climate policy. In the 1990s, the neoclassical notion of weak complementarity between environmental protection and growth dominated debates on sustainable development. In the mid-2000s, economic thought on the environment diversified, as the idea of strong complementarity between environmental protection and growth emerged in the green growth discourse.

Urgent action needs to be taken to reverse the urban population living in slums worldwide, which sees the vast majority of urban residents breathing poor-quality air and having limited access to transport and open public spaces. With the areas occupied by cities growing faster than their populations, sustainability has profound repercussions. Urgent action is needed to reverse the urban sprawl where a vast majority of the population is living under sub-par environmental standards. The diversification of ideas broadened policy advice from market-based policy to green industrial policy, including the deployment of subsidies and regulations that have been formulated to facilitate the shift from conventional approaches to sustainable alternatives.

One way of meeting human development goals whilst sustaining the ability of natural systems to continuously provide resources and ecosystem services is to envision a desirable future state for human societies, in which living conditions and resource use continue to meet human needs without undermining the "integrity, stability and beauty" of natural biotic systems. The term 'sustainability' should be viewed as humanity's target goal of human-ecosystem equilibrium

(homeostasis), while 'sustainable development' refers to the holistic approach and temporal processes that lead us to the endpoint of sustainability."

One of the key concerns of the SDG 11 concerned by sustainable cities and communities is rapidly gaining momentum and worldwide attention as a promising response to the challenge of urban sustainability. This pertains particularly to ecologically and technologically advanced nations. Metropolitan development, urban growth, and demographic expansion are incurring an unpreceded demand for more construction. These building facilities cause a lot of environmental problems during construction, operation, maintenance, and destruction. Buildings consuming large amounts of energy and natural resources have an impact on climate change by affecting the quality of air and water in cities (Vyas et. al., 2014).

These environmental problems caused by the construction industry can be substantially decreased via a change in the modes and applications. Besides, the most explicit or measurable effect of industrialism is on the environment, and its socio-economic effects also cause important disadvantages (CIB & UNEP-IETC, 2002). Intensive usage of natural resources throughout construction and demolition processes results in solid and liquid wastes as well as gas emissions negatively impacting the environment. These negative impacts can be summarized as consumption of non-renewable resources, decrease in biological diversity, destruction of forest areas, loss of agricultural areas, air, water, and soil pollution, destruction of natural green areas, and global warming.

Reversing the building contribution in favor of global climate change is one of the objectives that can be reached either by “sustainable architecture”, “sustainable construction” or “Green buildings” concepts serving a systematic approach to the subject by determining prominent principles, strategies, and methods for finding solutions to environmental problems caused by building. Maximizing the efficiency and effectiveness of buildings can significantly reduce greenhouse gas emissions over the lifespan of a structure. Green Buildings will regenerate and sustain the health and vitality of all stakeholders’ lives.

Lebanon is a particular Mediterranean country witnessing the socio, political and economic challenges. The recent crisis, ranging from 1975 to late 2020, has considerably affected the GDP of the country, which is estimated to have only grown by 0.2 percent, compared to 0.6 percent in 2017, as the International Monetary Fund predicts an additional 12% decrease for the coming years. This deceleration in economic activity is linked to a policy-based tightening of liquidity,

specifically, the halt in subsidized lending by the central bank channeled via commercial banks to the real estate sector mostly, providing a rare source of growth impetus since 2012. Understanding the challenges the Lebanese have to overcome to shift to construction sustainability presents a huge undertaking.

Environmental sustainability and its derivatives literature have increasingly recognized the importance of integrating Human actors along with non-human actors with other value chains. Though the value of such integration is uncontested, it does raise several questions relating to stakeholder collaboration.

Sustainable construction incorporates a wide array of stakeholders such as architects, engineers, landscape architects, product manufacturers, energy consultants, project managers, building users, and local administrators working together. Despite substantial research in the field of environmental sustainability, there remain gaps in understanding the complex dynamics of actors' collaborations in play, specifically in the field of construction, as a key pillar of economic growth and demographic expansion. The complexity of the stakeholders involved in the construction sector (from design to implementation) alongside the complex "role-play" and responsibilities of each element, justify the need to rely on theories borrowed from multiple disciplines in strategic management and information systems theories to guide sustainability in construction.

Theories such as the Stakeholders Theory (ST), and Actor-Network Theory (ANT). In particular, the ANT constructed by Latour and Callon (1987) will reflect the need to adopt a less rigid sequential planning facilitating conceptualization, actor enrolment, fact building, and translation circulation. The Stakeholder theory, Freeman (1984), will translate each stakeholder's influence on the process and inversely how the process responds to these influences.

Rising from the importance to bridge the quest toward sustainable construction and current practices in developing Mediterranean countries, this thesis is based on an analysis of the situation in Lebanon to aid in gearing to sustainable construction through stakeholders. As their influence was addressed using a comprehensive multidisciplinary approach.

In Lebanon, few studies have been conducted to investigate the problems being experienced by the Lebanese construction sector. However, limited insight is provided into the role of stakeholder management knowledge in gearing construction projects from conventional to sustainable. Moreover, a procedure for involving and controlling stakeholders is lacking. To

bridge this gap and contribute to solving some problems associated with the construction industry in Lebanon, this research aims to highlight the pivotal activities and stakeholders' inferences during the pre-construction stage for construction projects in Lebanon. Using social network analysis to illustrate the differences in stakeholders' involvements, concerns, and input importance in a project.

This focuses on how stakeholders in construction projects contribute through their sphere of influence to achieve SDG 11 on sustainable cities, in a complex developing Mediterranean country like Lebanon.

In the global quest toward environmental sustainability, this thesis aims to understand the challenges hindering Lebanon from shifting to sustainable construction. In particular:

- Is a Smart City a viable solution to addressing urban pressure and thus lead to sustainability in Lebanon? Highlighting its Limitations.
- Are Green Buildings /Green Rating Systems a viable solution toward sustainability for Lebanon? Findings and Limitations.
- How can we Influence/Guide SC? Defining the role of Stakeholders.

Summarizing the complexity and the difficulties faced by most Mediterranean coastal countries, Lebanon is considered in this thesis as a projection for the challenges of the construction sector in its inevitable quest toward sustainability in line with 2030 international goals. This thesis is structured around the construction sector considered a key pillar of the economy while incurring a considerable impact on the environment and this represents a high potential in influencing and gearing sustainability.

This thesis contributes to the field of sustainability in construction projects from both practical and theoretical perspectives. From the Practical perspective, it provides insight into the role of inferential stakeholders in Lebanese construction projects and guides policymakers towards informed decisions on sustainable construction. It also proposes sound recommendations to review the role of a key inferential stakeholder, the order of Engineers and Architects in Lebanon towards more impact on gearing sustainable construction. The Theoretical perspective addresses the application of management and information system theories (stakeholder theory and actor-network theory) in a multidisciplinary environmental field. Using social network analysis to determine the complexities and interests of the stakeholders, biased evaluation, and performance control.

The thesis is divided into 3 parts consisting of eight chapters in addition to an Introduction and a conclusion. **Part 1: Chapter 1** reviews the literature on the context of the research, the concept of sustainable development and sustainability in construction along with stakeholders' participation in construction projects along with stakeholder mapping and classification. **Chapter 2** provides a theoretical framework for this research. An investigation of stakeholder theory and project management is reviewed in this chapter. Actor network theory was also addressed. Bringing these theories together will provide a greater understanding of how the stakeholder's involvement, input, and role increase the possibility of undertaking sustainable construction projects. **Part 2: Chapter 3** illustrates Lebanon as a complex Mediterranean country by depicting the Lebanese economic structure, emphasizing the importance and situation of the construction sector. **Chapter 4** describes the research methodology adopted within the thesis. Including the research framework which includes design, approach, and strategy. As well as the activities and techniques used in the analysis process for this study, then concluding with the research limitation. It also provides further details concerning how data was collected, illustrated, and the data selection criteria. Including Social network analysis, Geographical information systems. **Part 3: Chapter 5** answers research question 1 by discussing the possibility of establishing smart cities in Lebanon and providing a situational analysis of green buildings. **Chapter 6** addresses research question 2, with the identification of the relative importance of stakeholders' involvement in sustainable construction. **Discussion and Conclusion** provides an overall discussion that merges the findings of the studies in three phases, ending with the conclusion and its limitations and directions for future research finally the reference list and supplementary information are provided in the Appendices.

PART 1: Research Framework

Chapter 1: Conceptual Framework for Sustainable Construction Projects

1.1. Section 1: Sustainability in Construction Projects

1.1.1. Sustainable Development- SDG 11 on sustainable cities

Lebanon has a rich cultural heritage. It is home to some of the world's oldest cities. However, the country has witnessed several demographic changes, including a high level of conflict-induced urbanization. These waves of external and internal displacement result in an increasingly complex urban context and can make it more difficult to maintain social coherence and ensure inclusion (Goal 11: Sustainable cities and communities | UNDP in Lebanon, 2022).

Sustainable Development Goal 11 (SDG 11 or Global Goal 11), titled "sustainable cities and communities" is one of the 17 Sustainable Development Goals established by the United Nations General Assembly in 2015. The official mission of SDG 11 is to "Make cities inclusive, safe, resilient and sustainable. (United Nations, 2017).

The 17 SDGs (Figure 1) take into account that action in one area will affect outcomes in other areas as well and that development must balance social, economic, and environmental sustainability(United Nations, 2020).

Figure 1: Sustainable Development Goal (United Nations, 2020).

Sustainable Development Goal 11 is divided into ten (10) targets and fifteen (15) indicators at the global level (Figure 2).

SDG	Targets	EU SDIs Framework
Goal 11. Make cities and human settlements inclusive, safe, resilient and sustainable	11.1 by 2030, ensure access for all to adequate, safe and affordable housing and basic services, and upgrade slums	-
	11.2 by 2030, provide access to safe, affordable, accessible and sustainable transport systems for all, improving road safety, notably by expanding public transport, with special attention to the needs of those in vulnerable situations, women, children, persons with disabilities and older persons	(People killed in road accidents)
	11.3 by 2030 enhance inclusive and sustainable urbanization and capacities for participatory, integrated and sustainable human settlement planning and management in all countries	-
	11.4 strengthen efforts to protect and safeguard the world's cultural and natural heritage	-
	11.5 by 2030 significantly reduce the number of deaths and the number of affected people and decrease by y% the economic losses relative to GDP caused by disasters, including water-related disasters, with the focus on protecting the poor and people in vulnerable situations	-
	11.6 by 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality, municipal and other waste management	1: Municipal waste generation and treatment, by type of treatment method 2: Urban population exposure to air pollution by particulate matter 3: Urban

Figure 2: Millennium Development Goal 11 target and indicators (United Nations, 2020).

SDG 11 represents a paradigmatic shift in international development cooperation from poverty. It is a rural phenomenon recognized in the global south cities facing challenges with extreme poverty, environmental degradation, and risks due to climate change and natural disasters. Despite its ambiguous targets and goals, SDG 11 still has its place as a tool to address urban challenges as it requires actors to develop realistic, locally defined indicators and outputs that fit in the urban context of specific cities to promote sustainability, inclusiveness, and equality among the cities (Danish Institute for international studies, 2015).

More than half of the world's population now lives in urban areas. That number is expected to reach 6.5 billion people2050. According to the UN, we cannot achieve sustainable development without significantly re-engineering the practices of construction and management for urban spaces (Goal 11: Sustainable cities and communities | UNDP in Lebanon, 2022).

The continuous expansion and urbanization growth rate have necessitated the creation of additional space for housing, social facilities, commercial, and other urban land usage. This leads to urban sprawl phenomena and presents a variety of negative effects such as: increasing the distance between homes, businesses, services, and job places which resultantly enhances the infrastructure, transportation, and public servicing costs. Furthermore, the absence of a well-defined urban plan has resulted in an urban expansion that has encroached on ecologically sensitive regions, significant agricultural areas, and locations that are not suitable for development. Land usage disputes have also arisen due to the increasing demand for land usage in important regions. These circumstances have exacerbated several urbanization difficulties including pollution, traffic congestion, the loss of green space, and a decline in the quality of urban life.

1.1.2. Sustainability in Construction

The construction industry has shifted from its traditional practices toward sustainable development and has received close global attention in the form of "sustainable construction" (Kuhlman & Farrington, 2010). Sustainable construction is technically complex because it involves multidisciplinary designers and engineers with green expertise with diversity and multicultural (languages, nationality, and religion) project teams at multiple levels. Alongside their traditional roles (time, scope, and cost), project managers could be sustainability drivers within the project teams. As the sustainable construction phenomenon continues to grow and gain popularity, there is a need to improve essential attributes that project managers should possess to manage a sustainable construction project. Project managers face several challenges while implementing a green building, particularly within the pre-construction phase (Robichaud et al., 2011) which requires them to determine sustainable goals and establish a framework for future decision-making at all construction phases (Hwang et al, 2013).

1.1.2.1. Smart City

The trajectory of rapid urban population growth requires a demanding imperative for sustainable development and better livability. The expansion of cities faces a variety of challenges (Washburn et al, 2010). Another set of problems is social and organizational rather than technical, physical, or material. Concerns are substantially associated with multiple diverse stakeholders, high levels of interdependence, competing values, and social and political complexity. In this sense, problems become dilemmas (Rittel,1973).

To prevent rapid urbanization from becoming a crisis is to operate cities innovatively. To that end, building smart cities is a new approach to urban development. The smart city approach is emerging as a way to solve these particular dilemmas and problems inherited in rapid urbanization. Since the disadvantages of urbanization are social, political, and organizational, smart city strategies for innovation must consider management and policy as well as technology (Nam and Pardo, 2011).

The Smart City (SC) refers to that place and territorial context, where the use of planned and wise human and natural resources, properly managed and integrated through the various Information and Communication Technologies (ICT) already available, allows for the creation of an ecosystem that can be used of resources and to provide integrated and more intelligent systems (Lazaroiu et al., 2012).

Smart sustainable cities are rapidly gaining momentum as a holistic urban development approach. The concept is evolving into a global realist enterprise, not least within ecologically and technologically advanced nations. In the overall quest towards sustainability, cities are either adopting the “Smart City Approach” or result in reaching a certain level along the process through private and scattered initiatives ranging from green buildings to environmentally friendly neighborhoods (Bibri, 2018).

When discussing Smart City, one might think about a developed urban area that creates sustainable economic development and high quality of life by excelling in multiple areas, including economy, mobility, environment, people, living, and government (Karnouskos and De Holanda, 2009; Lazaroiu and Roscia, 2012; Albouy et al., 2013). Excelling in these areas can be achieved through strong human capital, social capital, and/or Information and Communication (ICT) infrastructure (Moslehi, 2010). We adopted the Smart Cities definition by Giffinger 2007, which are those cities qualifying simultaneously to indicators on Governance, Economy, Mobility, Environment, People, and Living (figure 1).

One of these indicators is the environment, which can also be divided into several parts, one of which is green-rated buildings. Green Rated buildings are constructions that comply with international, regional, or national standards and that reduce or mitigate negative impacts on the climate and natural environment through their design, construction, or operation. (Worldgbc.org, 2018).

1.1.2.2. Green Building

Building design, construction, operation, and maintenance require innovation in both engineering and management. The conventional methods are very demanding, therefore, it is important to look for a more responsible approach that will satisfy the needs of construction and development without damaging the world we live in (refer to figure 3).

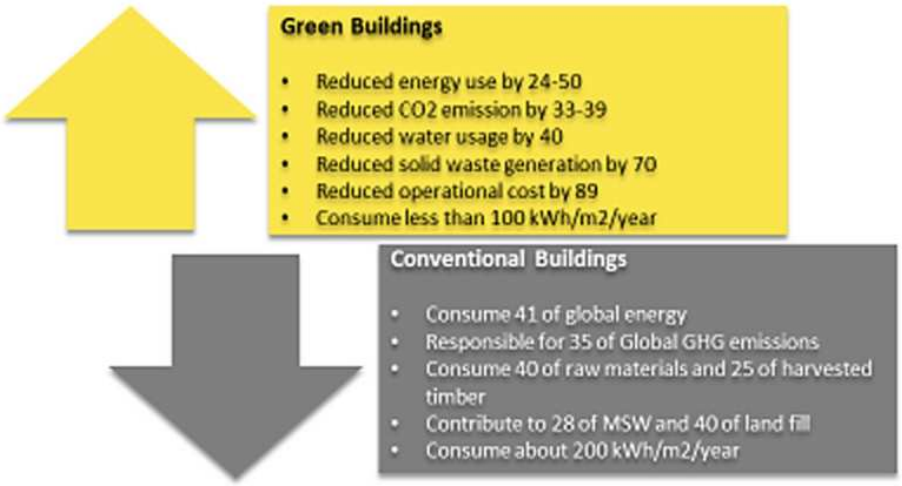


Figure 3: Green building vs Conventional buildings Source: R. AL-Dabbagh: Renew. Energy Environ. Sustain. 7, 3 (2022)

The inefficiency of buildings in terms of energy and resource usage constitutes a large societal challenge in connection to our total consumption and CO^2 footprint. Moreover, it also puts pressure on the total integrated energy and city system. Through energy efficiency measures and intelligent design, buildings can go from being a part of the problem to a solution, with the potential of being integrated into a smart, livable and sustainable city.

Green building concepts are gaining popularity and serve as a standard to mitigate the environmental impact of the new and existing building stock. Green building (GB), which offers an opportunity to reduce adverse impacts of buildings on the environment and occupants, has attracted much attention recently. There is no single, widely accepted definition for GB. A concise definition of a GB is provided by ASTM Standard E2114– 08, as "a building that provides the specified building performance requirements while minimizing disturbance to and improving the functioning of local, regional, and global ecosystems both during and after its construction and specified service life" (Goh and Rowlinson,2015). GB has been used as a term interchangeable with sustainable building, sustainable construction and high-performance building. Research

studies conducted on GB in the past decade are on an increasing trend and the focus is on the methods and tools used to assess the environmental performance of buildings (Zhang,2013).

Green building assessment methods play an essential role in promoting the development of green buildings and have gained popularity in recent years. Green building is an approach to environmentally friendly building design that aligns with the philosophy of sustainable growth. The term 'green building' is known as constructing structures and buildings throughout the building life cycle using environmentally friendly, resource-efficient methods, from site to design, construction, operation, maintenance, reconstruction, and deconstruction (Kuhlman,2010). Green buildings are generally referred to as sustainable buildings and high-performance buildings with health and quality of life improvement mechanisms (Shi and Zhang,2014).

According to Augenbroe and Pearce (2009), fifteen (15) elements of green building have been identified which include: energy conservation measures, land use regulations and urban planning policies, waste reduction measures, resource conservation strategies, indoor environmental quality, friendly energy technologies, re-engineering design process, proactive role of material manufacturers, better measure and account for costs, new kinds of partnership and projects, adoption of incentive programs, education and training and recognition of commercial buildings as productivity assets.

The concept of green building has been adopted by many nations as it is a viable option for preserving resources and environmental sustainability (Samer, 2013). Documentations on green building suggested that green building has been used worldwide. According to Reed, Bilos, Wilkinson, and Schulte (2009), the developments in green building practices are traceable to UK's Building Research Establishment (BRE) which pioneered the first assessment scheme called Building Research Establishment Environmental Assessment Method (BREEAM) in 1990 followed by USA Green Building Council's Leadership in Energy and Environmental Design **(**LEED) in 1996. The green building evaluation system varies from country to country due to the differences in climatic conditions, national situation, industrial development, and social and economic factors with relevant adjustments

1.1.2.3. Green Rating Systems

A Green Building Rating System (GBRS) is defined by Nguyen and Altan 2011 as a tool that the building industry uses to evaluate, enhance, and/or promote developments' sustainability. Those

systems provide a tool, guidance, and/or better insights into sustainability through information analysis, valuations, and comparisons (Goh et al, 2015).

They try to facilitate the following:

1. Enhance buildings' operational performance,
2. Minimize environmental impact,
3. Measure buildings' effect on the environment,
4. Objectively evaluate and judge buildings' development

Various GRS national and internationally are adopted in Lebanon. Three systems are presented with respect to them addressing and prioritizing the sustainability pillars; two internationally applied; LEED and BREEAM, and one developed for Lebanon, ARZ. Highlighting background information.

1.1.2.3.1. International Green Rating Systems adopted in Lebanon

The Lebanese criteria for green buildings were initially published in March 2017 by the order of engineers and architects in Beirut. They clearly stated that if a new construction project is registered and commits to seeking LEED, BREEAM, or other approved international green building certification, it is considered compliant with the criteria of For Green Buildings in Lebanon. Building rating systems have been developed in other countries to meet their specific needs. While these rating systems are widely used outside their founding countries, it was LGBC's view that a home-grown system is necessary to take account of the specific challenges and opportunities facing buildings in Lebanon.

The Lebanon Green Building Council, with support from IFC, a member of the World Bank Group, launched ARZ, a rating system that will evaluate the energy efficiency of commercial buildings in the country to encourage better resource management, which decreases energy costs and addresses climate change.

Developed with IFC technical assistance, the new system will help commercial building owners in the country assess their structures' impact on the environment and recommend changes to reduce energy and water waste. Buildings will be rated either certified, bronze, silver, or gold, and it is expected that, once widely adopted, the ARZ rating system will encourage building owners and facility managers to achieve ever-higher certification levels to attract discerning tenants and

clients. ARZ (Building Rating System) BRS is an evidence-based approach to assessing how a green building is.

The ARZ Building Rating System is designed to measure the extent to which existing commercial buildings in Lebanon are healthy, comfortable places for working, consuming the right amount of energy and water while having a low impact on the natural environment. In addition, the rating system will stimulate building owners and facility managers to achieve ever-higher certification levels to attract discerning tenants and clients.

1.1.3. The Construction Project Management Phases

A building project is composed of processes. A process is ‘a series of actions bringing about a result’ (PMBOK,2017). Each process is performed by a person or organization. Generally, there are two broad categories of processes: project management processes and product-oriented processes (PMBOK,2017).

Although working in the construction industry needs a broader viewpoint, project management is often characterized as managing resources across the duration of a project's life cycle utilizing a variety of tools and methods to regulate scope, cost, time, quality, and so forth. A wider range of limitations specific to the planning and execution of construction projects are frequently included in construction management. Architecture, engineering, public works, and city planning are just a few of the disciplines that construction project management may engage with during a project.

There are a variety of construction projects, depending on the versatility and diversification of construction sectors. There are two sectors in construction: residential and commercial. There can be up to four different types of projects with respect to the demands of the construction sector,

- Residential home building and renovation
- Heavy industrial construction
- Commercial and institutional construction
- Engineering construction

As a result, there is a wide range of construction projects which require effective construction management. On the other hand, construction project managers oversee the initialization and completion of a project's construction, typically overseeing on-site to guarantee a safe and successful outcome. Construction projects are complicated, requiring a wide range of skills. Even

when the project is well underway, additional tasks can be added at any time. During the project's life cycle, all of these activities must be performed and finished.

A construction project's lifetime may be broken down into three distinctive phases. Each phase consists of a number of tasks that must be performed before going on to the next. A project that follows this procedure to the letter will have a higher chance of success.

1.1.3.1. Pre-Construction Phase

1.1.3.1.1. Initiation Phase

In the initiation phase, the project objective or need is identified; this can be a business problem or an opportunity. An appropriate response to the need is documented in a business case with recommended solution options. A feasibility study is conducted to investigate whether each option addresses the project objective and a final recommended solution is determined. Issues of feasibility ("can we do the project?") and justification ("should we do the project?") are addressed. Once the recommended solution is approved, a project is initiated to deliver the approved solution and a project manager is appointed. The major deliverables and the participating workgroups are identified, and the project team begins to take shape. Approval is then sought by the project manager to move on to the detailed planning phase.

1.1.3.1.2. Planning Phase

In the planning phase, the project solution is further developed in detail catering to the needs of every aspect, and the steps necessary to meet the project's objective are planned. In this step, the team identifies all of the work or tasks to be done. The project's tasks and resource requirements are identified, along with the strategy for producing them. This is also referred to as "scope management." A project plan is an outlining of the activities, tasks, dependencies, and timeframes. The project manager coordinates the preparation of a project budget by providing cost estimates for the labor, equipment, and materials. The budget is used to monitor and control cost expenditures during project implementation.

Once the project team has identified the work, prepared the schedule, and estimated the costs, the three fundamental components of the planning process are complete. This is an excellent time to identify and try to deal with areas that might pose a threat to the successful completion of the project.

Finally, it will lead to documenting a quality plan, providing quality targets, assurance, and control measures, along with an acceptable plan, listing the criteria to be met to gain customer acceptance. At this point, the project would have been planned in detail and is ready to be executed.

1.1.3.2. Construction Phase

The project plan is put into action and work on the project is to be done throughout the construction phase. People are doing the duties they have been given, and frequent team meetings allow for the reporting of progress. By comparing the progress reports with the project plan, the project manager may gauge how well the project activities are performing and take necessary corrective action. This information helps the project manager maintain control over the project's direction.Throughout this step, project sponsors and other key stakeholders should be kept informed of the project's status according to the agreed-on frequency and format of communication. The plan should be updated and published on a regular basis.

The projected endpoint in terms of cost, timing, and product quality should constantly be emphasized in status reports. Every project output should be examined for quality and compared to the acceptance standards. The project is ready for closing once all deliverables have been completed and the customer has approved the final solution.

1.1.3.3. Post Construction

1.1.3.3.1. Closing Phase

In the completion phase, the emphasis is on releasing the final deliverables to the customer, handing over project documentation to the business, terminating supplier contracts, releasing project resources, and communicating the closure of the project to all stakeholders. The last step is to conduct lessons-learned studies to examine what went well and what didn't. Through this type of analysis, the wisdom of experience is transferred back to the project organization, which will help future project teams.

1.1.3.3.2. Total Cost of Ownership

It is vital for the owner and the whole project team to look at the project from a total cost of ownership standpoint. This takes into account all the expenses and the overall environmental effect of the project throughout its existence (Refer to Figure below).

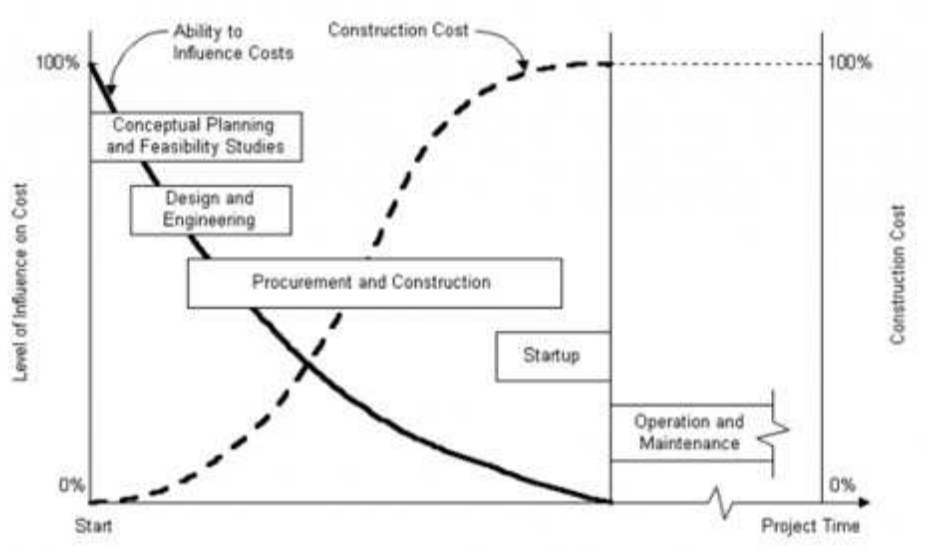


Figure 4: Cost/Influence Curve (PMBOK,2006)

It is important to keep in mind that most choices that have an impact on a facility's lifecycle cost are made in the preliminary stages of a project, such as planning and early design. Even if the system is less expensive, it can be highly challenging to cut total costs once the design has been completed and the materials have been ordered owing to the expenses of making the change. This is because it is much easier to change a system in the early phases of a project. Analyzing a facility's entire costs and repercussions for society and business is equally important.

1.2. Section 2: Stakeholders' Participation in defining construction project

1.2.1. Identifying and analyzing Project Stakeholders

Projects do not exist in isolation. Even if there is a defined brief, budget, program and scope of work the project is still subject to external influences. The project exists within a 'political' environment, populated by all those who have a particular stake or interest in the outcome of the project (PMI, 2021).

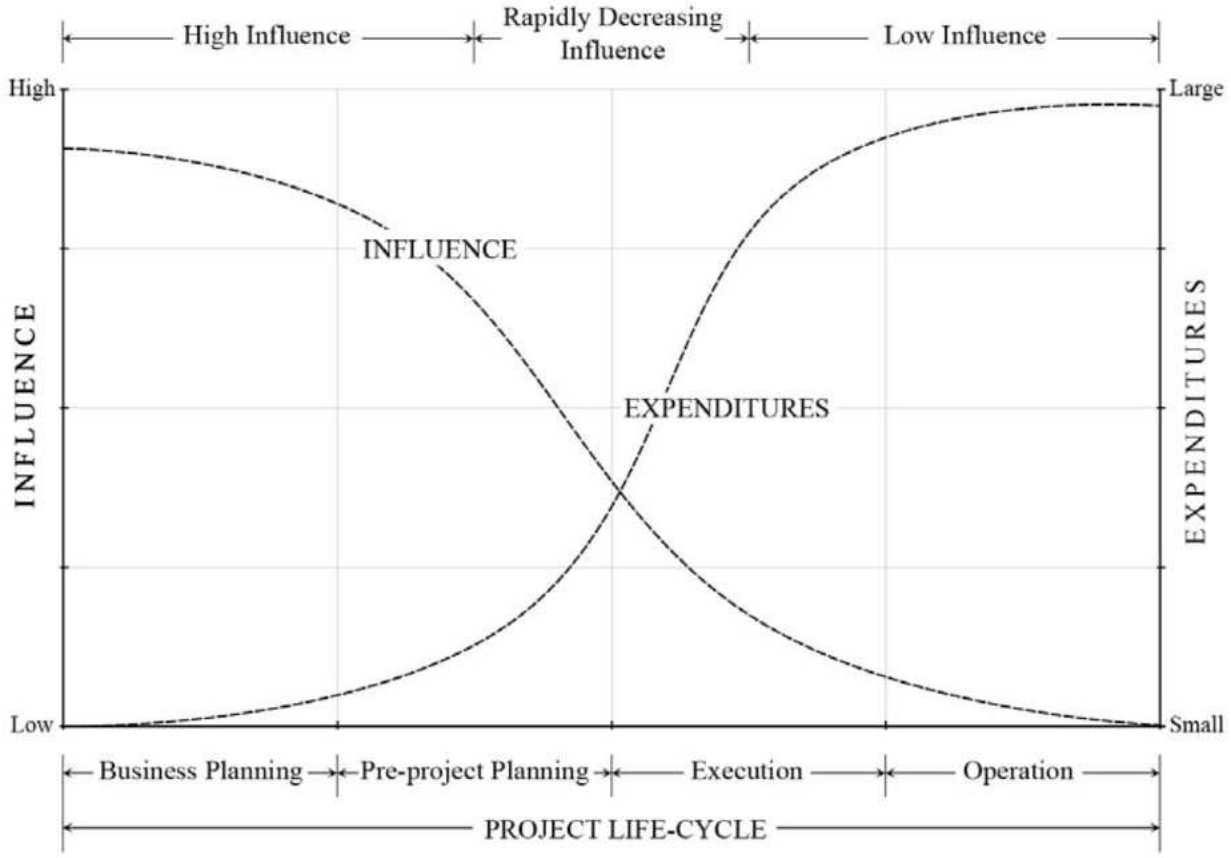


Figure 5: Influence and expenditure relationships throughout a project life-cycle (Gibson et al, 1995).

The political environment and the stakeholders' expectations represent a significant risk to a project. It is unlikely that the requirements of all stakeholders will overlap, as such, they will likely seek to influence the project to meet their requirements.

Pressure from stakeholders generates change which increases the complexity of the management task, jeopardizing cost and program certainty. However, if the views of project stakeholders are not addressed and stakeholders are not involved in the project's development, then the project is unlikely to deliver optimum value for all involved. Project managers must strike the right balance between stakeholders' involvement and isolation of the project from external influence to achieve the delivery on cost and maximize the benefit for the client and their stakeholders.

Stakeholders are individuals who have any stake or interest in a project or strategy undertaken by a company or an organization (Freeman, 1982). They will be affected by the project and interested in influencing it. If they benefit from the project, they will be supportive and positive. On the other hand, if the project harms their interests or is considered to have a negative effect on them, they may try to halt it or, at the very least, paint it in a negative light.

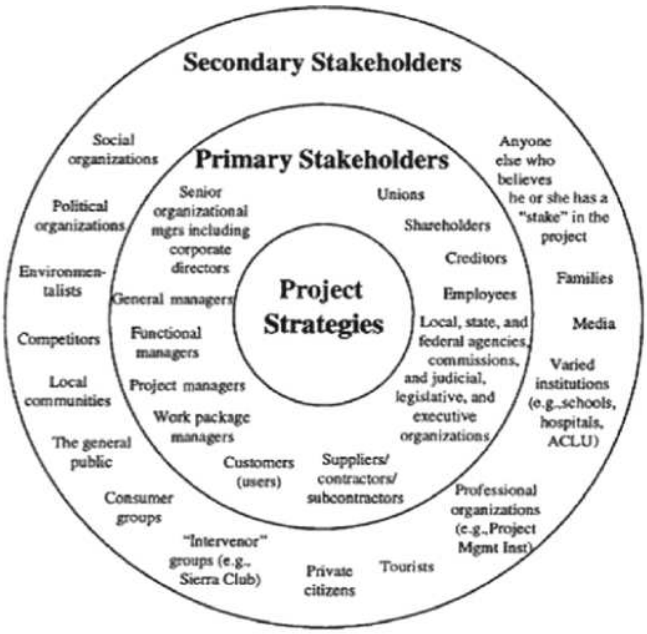


Figure 6: Description of Project Stakeholders structure in a common project (Mashwama et al. ,2019).

In construction projects, stakeholders can include several groups, for example, owners, government authorities, engineers, architects, and general public funding agencies. It generally falls to the client to manage project stakeholders. To do this, the client should reconcile the deviating stakeholder requirements and pass clear directions to the project manager. The client representative liaising with the different project stakeholders to gain their agreement might result in sign-off on the design at different stages becoming a lengthy process or 167A{} Q delayed briefing information and answers to questions.

Stakeholder influence is often felt most keenly in the early stages of the project. The project is flexible at this stage, and stakeholders are generally aware of this. Once it starts to progress and takes on momentum and power of its own, the cost of stopping it or altering its direction becomes high. Stakeholder influence often drops off markedly when construction starts but will increase again as handover nears. Project managers should continue to manage stakeholder(s) expectations to ensure that the completed building meets the needs of stakeholders and is favorably accepted. Some clients are better at managing stakeholder influence than others, and some stakeholders are easier to manage than others.

1.2.1.1. Internal and External Stakeholders

1.2.1.1.1. Internal Stakeholders

There are broadly two groups of internal and external project stakeholders for the client organization. The most well-known are the external stakeholders. The management of internal stakeholders, however, is often more problematic. In construction projects it is often difficult to identify who the client is. There may be a nominated single point of contact, but this person is not really the 'client' but just the representative of the client organization. Very often, it is the case that this person has the responsibility of juggling a whole range of different requirements within the client organization, and, as a result, they will be subject to many influences which may affect the project. Within the client organization, there will be a whole range of individuals with different 'stakes' in the project. Unless the nominated client representative takes a very strong line, they will succeed in influencing the course of the project.

1.2.1.1.2. External Stakeholders

External stakeholders are individuals or organizations that are not part of the client organization but have an interest in the project. Stakeholder groups are most readily recognized.
For public-funded projects, there are a large number of stakeholders.
These generally consist of funders, whether government departments, grant providers, private sector partners, or Users, whether these be passengers for a transport project or visitors to a museum and/or Regulatory agencies. Most commonly, the planning authorities are considered to be among the external stakeholders, as are specialist regulatory authorities, those involved in construction projects, and everyone affected by the project, like neighbors or those working or living nearby. It is relatively easy to identify forty individual stakeholder groups for a significant

public project, although private-sector projects tend to have slightly fewer. One of the key problems with stakeholder management is the sheer number of people involved and the fact that their levels of power and interest differ markedly. Management of the stakeholder environment is a highly complex management task.

1.2.1.2. Stakeholder Analysis

- Stakeholder analysis can be used to understand the stakeholder environment and to prioritize management resources. It is as follows:
- The first step is to identify stakeholders
- Next, decide on the level of power and interest of every individual stakeholder who can influence the project. The assessment can only be based on the perceptions of the project manager. (Refer to Figure 8 below)

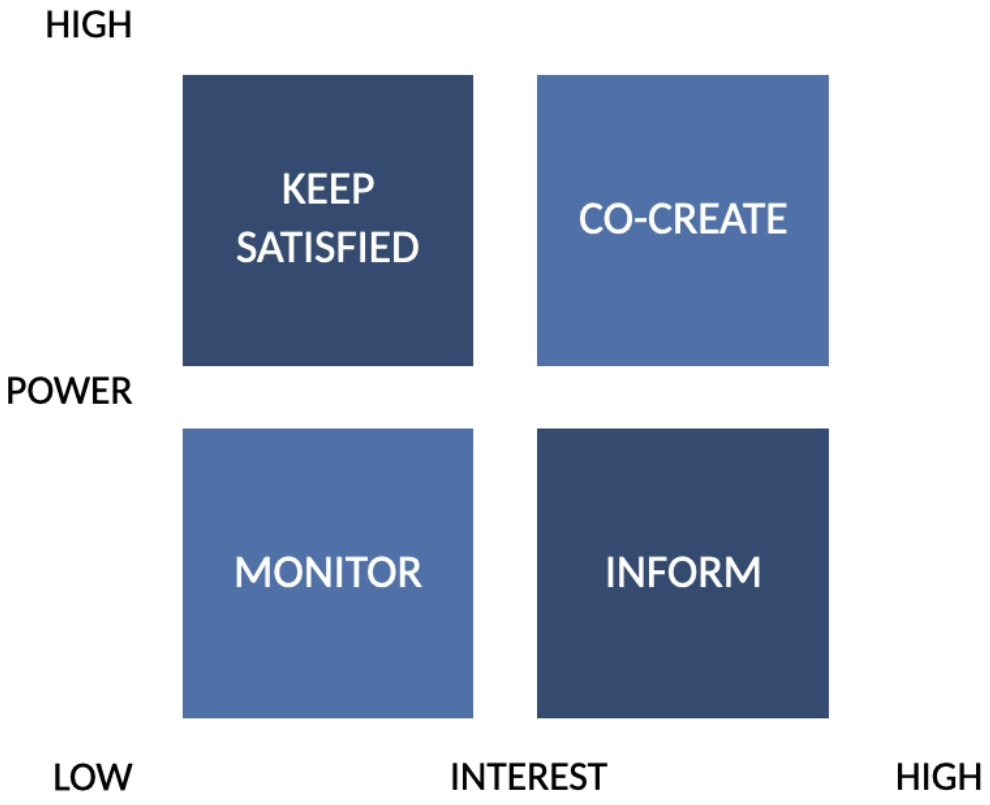


Figure 7: Stakeholder Power Impact Matrix adapted from Johnson, G. & Scholes, K. (2002)

1.2.2. Stakeholder Management

Managing the project is a fundamental need. As a result, the bottom right corner contains the good stakeholders, whereas the outside of the corner contains the negative stakeholders. Due to the

matrix's dynamic nature, changes in individual stakeholder organizations or changes to the project will be reflected in it.

High Power, High Interest

If they are supportive, including them in the initiative and receiving their support are crucial. Include them in the steering committee for the project, give them a say in decisions, utilize them to influence other organizations, and make sure they express their support.

High-power individuals who have bad interests pose a serious threat and are challenging to manage. Make an effort to counteract any unfavorable impact they could have on other groups. If feasible, their power has to be diminished.

High Power, Low interest

The group with great power but little interest is the most erratic; while their interest may be low right now, if the project or the individuals change, it may suddenly surge, and they will use their influence to modify the project.

High Interest, Low Power.

If they are supportive, they are powerful allies; information must be supplied, they must be involved, and they may aid in lobbying other organizations. If the answer is no, they will likely squander time by asking a lot of pointless inquiries.

Low Power, Low Interest

If they are helpful, provide them relevant information as their attitude can shift in the future. In order to manage stakeholders' effect on the project and interactions with them, prior research revealed strategies to map and categorize stakeholders. The categories of various stakeholders reflect the diversity of their perspectives on the project. In other words, the relevance of various stakeholders to the project as a whole varies. To enhance the project briefing process, this research evaluates the significance of each project stakeholder, both internal and external, for each part of the project scope definition.

Summary

Like all management models, the key benefit of stakeholder analysis is that it provides insight into a complex situation and therefore helps project managers and teams manage and communicate

with stakeholders in the most effective way, enabling them to concentrate resources where the maximum benefit will be derived and informing communications planning for the project. The benefits are very much in the discipline of having undertaken the process.

However, stakeholder analysis is only a tool that helps the project manager and the team identify the management actions necessary. It is perhaps most easily applicable to the management of external stakeholders, and a useful output of stakeholder analysis is a project communications plan, which will help the team define and understand which stakeholders they need to communicate with and how. A typical format for a project communications plan is given below. The output of the stakeholder analysis exercise can be used to help define the recommended approach and action plan. In a large project, this helps define the clarity of communication routes and ensure consistency.

Chapter 2: Theoretical Framework for Management Information Systems in Construction Projects

This chapter provides the theoretical framework for this research by examining the links between Actor-Network Theory, Stakeholder Theory, and sustainable construction and arguing that applying a stakeholder lens to information system theories of value creation can inform the achievement of sustainable development goals. We review the literature at the crossroad of stakeholder and Management information systems, highlight the role of stakeholders and stakeholder relationships in sustainability in construction projects, and identify key themes. While the research has tended to adopt a narrow view of stakeholder enrollment and management, it has the potential to shed new light on the management of the novel, complex, and uncertain settings and relationships that characterize attempts to understand and tackle societal challenges. This chapter is an investigation of stakeholder theory and Actor-network theory. Furthermore, it establishes that the types of networks existing between human and non-human actors in a construction project will have an impact on the actors to shift to sustainable construction. Bringing these theories together will provide a greater understanding of how stakeholder involvement and input increase, which in turn increases the chance of achieving sustainable construction.

2.1. Management information Systems - a Multidisciplinary approach

The importance of information technology (IT/IS) in the architectural / engineering/construction (A/E/C) industry has grown exponentially over the past few decades (Yu and Lee 2006). The reason for this is that multiple information system tools have been utilized for gathering, integrating, and disseminating the output of project management processes among project participants, and are used to support all aspects of a project from initiation through to closing.

Information systems are created to provide useful decision-making information to individuals and groups by storing, keeping, processing, and managing information resources. Their values are realized when the information provided is applied to operations. Swanson (1974) claimed that information quality is a critical factor that determines the success of information systems and defined detailed factors for assessing information quality such as the rapidity of information resource acquisition and the usefulness of information resources. Meanwhile, Zmud (1979) insisted that accuracy and timeliness are the critical factors that determine information quality after he developed and empirically analyzed various information quality assessment factors.

Understanding the importance of information system discipline to the management one is of great benefit to construction project stakeholders as it will provide the project manager with concurrent details about pertinent issues instantaneously.

Despite the significance of IT in building projects, people are still essential for improving the effectiveness of information systems and establishing key performance indicators. This implies that users' perceived priorities should be better detected and handled. Since controlling emotions and achieving goals is crucial to the success of any project effort.

As a consequence, the researcher decided to pick actor-network theory, which is relevant to the field of information systems, and stakeholder theory, which is concerned with the human pertinent component. These theories are useful in construction management and come from several disciplines.

2.2. Applicable Theories in Construction: Stakeholder & Actor Network Theory

A complicated management system for deliverables, resources, and expectations governs construction projects.

To comprehend the complexity of projects and their diverse components, numerous theories have been established. The terms "hard paradigm" and "soft paradigm" refer to two major schools of thinking that have both an academic and a practical aspect.

The phrase "soft paradigm" is frequently used to denote a hazy focus on people or intangibles, whereas the phrase "hard paradigm" is frequently connected to reductionist methods and quantitative characteristics. The vast range of project management soft system paradigms includes this concept.

Soft paradigm is commonly associated with interpretive epistemology, inductive reasoning, and exploratory, qualitative techniques, which emphasize contextual relevance rather than objectivity. A practice-based approach to the soft paradigm emphasizes learning, participation, and the facilitated exploration of projects, and typically demonstrates an interest in the underlying social process. (Pollak, 2007).

This thesis primarily understands the link between project participants and the environment, focusing on people or the intangibles. Information systems are frequently helpful in comprehending these networks because, at the moment, technology is used to simplify and evaluate most initiatives. In the discussion of actor-network theory, this section is extended.

2.2.1. Actor Network Theory

According to Latour (1987), innovation is a process of translation by which a vague initial idea is shaped, diverted, and consolidated, to build up a network of allies who believe in, test, and carry forward the development of the innovation.

Actor-network theory (ANT) was developed in the 1980s by sociologists Bruno Latour, Michel Callon, and John Law as an alternative to traditional sociology. ANT offers an understanding of animate artificial intelligence. This theory describes a social world that is built upon connections between actors, who can be either human or non-human. In the words of Latour, "we should not

limit in advance the sort of being populating the social world" (Latour,1982). Non-human actors within ANT will be the focus of this research to determine how ANT relates to our subject area.

Actor-network theory (ANT) is a socio-philosophical approach that attempts to comprehend complex social situations by paying attention to relational elements referred to as associations (Latour, 2005) in ANT terminology (Pouloudi, 2000). The increasing popularity of ANT arises from a pivotal, though controversial, feature: the symmetrical treatment of human and non-human actors, and social and technical elements (Latour, 1996, 2005; Law, 1992). Under ANT, these heterogeneous elements are attributed equal importance and are seen as part of a dynamic and never definitive network, in which the essence of understanding sociological phenomena lies in the associations among them (Pouloudi, 1999).

“Exploration of "human agentive consciousness" "private realms of subjects" and "reflexive agents" in López-Varela (2010, p. 125) incorporates a dualism of subjects ("producers") and objects ("consumers") into the framework.” However, the focus (ibid., p. 127) on "betweenness" and computer-mediated communication enables the analysis of "inter-subjectivity" transcending individual, cultural, historical, and economic contexts.

Overall, the goal of ANT is to redefine the nature of what is "social" (Dankert, 2012). “ANT places itself in contrast to traditional sociology, which says that "there also exists a social context in which non-social activities take place; it is a specific domain of reality where ordinary agents are always 'inside' a social world that encompasses them. They can, at best, be 'informants' about this world and, at worst, be blinded to its existence."

In the information system literature, graphical representations often accompany Actor-Network Theory analysis of Information system initiatives, serving as tools for improving the visibility of the case and the interest and power of its actors (Bengtsson & Lundstrom, 2013). Although rigorous sequential planning is not feasible, Actor-Network Theory (ANT) demonstrates that by using three ANT rules—enrolling players, fact-building, and circulating translations—conceptualization is facilitated. These guidelines provide a "conditional path" in which particular activities are triggered as soon as issues arise.Using Fournier and Grey's (2000) framework as a root for their studies, Whittle and Spicer (2008) argue that ANT can provide researchers with a realist account of the stabilization of networks of human and non-human actors, based on a positive theory of knowledge, and explain how power relations are constructed."

Furthermore, according to Pouloudi, A. et al., (2004), there is little generic guidance on how such relevant actors can be identified when a different research context is under study. Moreover, they went further, arguing that they can be instrumental in providing generic, context-free guidance to stakeholder identification that was missing from ANT studies (Whittle, A. & Spicer, A. (2008).

2.2.2. Using Actor Network Theory to Identify Stakeholders

The implications of these principles for identifying human and nonhuman stakeholders in an actor network, as well as the networks themselves, is that stakeholders should reflect the dynamics of the local context and not be treated as static elements but, rather, revisited over time for new entries. Pouloudi (1998) suggests that each stakeholder can lead to the identification of further stakeholders.

Actor-network theory (ANT) has its origins in the work of Callon (1986,1991) and Latour (1987, 1992). According to ANT, humans and machines interact in a multiplicity of roles, together constituting networks that act as independent autonomous actors, the actor networks. An information system with its information technologies and its human users may be viewed as an actor network. In actor networks, actors collectively act; actor networks are by nature heterogeneous and information-based. Networks within ANT are also perceived as actors (Latour 1999; Suchman 2002). A key proposition of ANT is to treat human and nonhuman actors as well as networks symmetrically. However, there is little guidance on how these actors are identified (Pouloudi 2004).

However, the idea of following the actors cannot easily be translated into practical guidance for the researcher engaging with complex socio-technical phenomena. Stakeholder analysis is an approach much more explicit in this respect (Pouloudi 1999). However, the application of stakeholder analysis (unlike ANT) in the IS context has been predominantly restricted to the study of stakeholders who are people (Pouloudi, 2004).

In research and practice, combining stakeholder analysis with ANT gives a way to systematically identify ANT players, improving ANT analysis. By expanding the stakeholder identification process to nonhuman agents and networks, this thesis makes a contribution to the field.

A interpretative identification and analysis of stakeholders may be guided by a number of stakeholder behavior concepts proposed by prior IS research. This method makes the argument for iterative and dynamic stakeholder identification. Such a dynamic and iterative process relate

closely to some of the fundamental premises of actor-network theory, which "concentrates attention on a movement" (Latour 1999 p. 17).

2.2.3. Stakeholder Theory and Management

Since Freeman (1984) published his landmark book, "Strategic Management: A Stakeholder Approach"; the concept of "stakeholders" has become embedded in management scholarship and managers' thinking.

Stakeholder theory is one of the major, if not the most frequently used, approach in social, environmental, and sustainability management research (Frynas & Yamahaki, 2013; Montiel & Delgado-Ceballos, 2014). References to 'stakeholders' and stakeholder theory provide a starting point for analyses in several publications on corporate sustainability and sustainability management, no matter whether they are textbooks, research papers, or policy publications (e.g., Darnall et al., 2010; Doh & Guay, 2006; Husted & Allen, 2011; Kolk & Pinkse, 2007; Lee, 2011; Perez-Batres, Doh, Miller, & Pisani, 2012; Sarkis, Gonzalez-Torre, & Adenso-Diaz, 2010). Taking a closer look at the use of stakeholder theory in sustainability publications shows that many rather vaguely refer to stakeholders or even misinterpret the approach (cf. Elms, Johnson- Cramer, & Berman, 2011; Freeman, Harrison, Wicks, Parmar, & de Colle, 2010; Phillips, Freeman, & Wicks, 2003)

The term stakeholder is a powerful one due to the degree of its conceptual breadth. The term means different things to different people, which could evoke praise or scorn from a wide variety of scholars and practitioners (Philips et al, 2005).

Many scholars have argued that integrating stakeholders' knowledge and values in decision-making scenarios ostensibly lead to improved governance and accountability (e.g., Koontz and Thomas 2006, Wagenet and Pfeffer 2007).

Drawing on stakeholder theory, we consider how potential inter-stakeholder tensions contribute to both the challenges and opportunities for sustainability practices, unfortunately, doing so could potentially oversimplify complex interactions among stakeholders. Looking more deeply at nuances that differ among stakeholder groups within either the internal or external category is critical to identify the challenges facing said sustainability practices (Bouzon et al., 2020). More specifically, internal stakeholders are frequently developers and overseers of green activities, including senior administrators, procurement staff, users (employees), and internal specialists

(e.g., environmental or information technology professionals). These multiple stakeholder groups have a significant, but just as important, varying influence or degree of control over objectives, data gathering, and disclosure (Domingues et al., 2017)

In contrast to internal stakeholders, external stakeholders do not directly typically control organizational resources (Liu et al., 2021) or the procurement process. Instead, their influence occurs indirectly through their ability to shape public opinion and new regulations through multiple social and democratic channels (Brammer and Walker, 2011).

However, there are several overlapping stakeholder groups with distinct goals, such as voters, taxpayers, and residents, much like internal stakeholder groups. As a result, every external stakeholder group in the neighborhood has a unique point of view. Taxpayers are eligible to vote in municipal elections, although not all taxpayers do so; some taxpayers are prohibited from doing so; and some residents do not pay taxes or cast ballots. As a result, some residents might prioritize the accessibility and responsiveness of dependable services from municipal government agencies, while others might concentrate on community greening and value for money (Fraser Johnson & Klassen, 2022).

By balancing their objectives across several values and determining their impact on the purchase decision, stakeholder groups may be mapped. Due in part to the assumption that green products and services are more expensive than their conventional counterparts, costs and financial concerns are typically obstacles in the way of the adoption of sustainable structures (Walker et al., 2008). Second, prior studies have shown how crucial it is to organize stakeholder involvement in sustainability initiatives (Knoppen et al., 2021).Stakeholder theory is a reliable theoretical underpinning to assess how potential inter-stakeholder tensions inhibit the development and implementation of Sustainable practices. Stakeholder theory supports at least two dimensions to identify and map these tensions: weighting of priorities; and influence in decision making. Unfortunately, differing priorities and degrees of influence (or perceived powerlessness) contribute to inter-stakeholder tensions. Moreover, rather than viewing stakeholder groups through a lens that simply categorizes these multiple groups as internal or external, bridging them might potentially reconcile inter-stakeholder tensions and improve the implementation of sustainable buildings that include process-based collaboration (Fraser Johnson & Klassen, 2022).

Summary

Construction is a complex project involving various networks between project stakeholders or through liaising activities and milestones. This thesis addresses them through actor-network theory, which incorporates a description of actors through a network of human and non-human nature as expressed by Latour.

Actor-network theory studies provide detailed accounts of how human and non-human actors gradually form stable actor networks. However, due to their focus on a particular context, there is little generic guidance on how such relevant actors can be identified when a different research context is under study. The principles of (human) stakeholder behavior presented in this thesis guide the identification of human stakeholders through an iterative, interpretive, dynamic, and context-contingent process, showing how they can be adopted and extended to include the identification of nonhuman actors as well. Thus, we argue that they can be instrumental in providing generic, context-free guidance to stakeholder identification that is currently missing from ANT studies.

Human actor-network is expressed in ANT but evolved using Stakeholder theory (Freeman) involving identification, analysis, and management, thus by analyzing stakeholders and understanding their interactions and relationships, we can identify potential loopholes to exploit in promoting sustainable buildings instead of conventional ones and therefore enact their power and impact to shift construction from conventional to sustainable.

PART 2: Research Methodology

Mediterranean countries and in particular coastal cities are densely populated and have been facing, over the past 20 years, numerous problems arising from seasonal occupation to sprawling urbanization, and have been transformed by a combination of rapid technological and political change (Cohen, 2005). In a general approach, urbanization is a prominent and central feature of the sustainable development paradigm.

Since urban environments and especially those in the Mediterranean basin are particularly challenged by the principles of sustainable development as illustrated by the over-extension of urban areas and the excessively high level of energy consumption and wasted space, Mediterranean cities offer particularly promising opportunities for improvement. These opportunities will only grow more significant going forward. Lebanon on the eastern shore of the Mediterranean region is no exception.

Chapter 3: A contextual Analysis: Lebanon a Country of Multiple Complexities

Chapter 3 provides insight into Lebanon and its state of the art on SDG. Foregrounding the country's profile through the lens of SDG acquirements and failures. Exhibiting its financial position, social construct and environmental state. Elucidating the concept and state of sustainable practices in the construction process. Firstly, by determining the role of the construction and real-estate sector in Lebanese construction. Secondly, by illustrating opportunities and strong points on one hand and addressing threats and weaknesses specifically on the environmental front. Ending with a presentation of the current Lebanese state with its situational changes.

3.1. SDG's Country Profile: Lebanon

For the second year in a row, the world was no longer making progress on the SDGs, in 2021 average SDG Index scores had declined slightly from 2020: the pandemic and other crises have been setbacks for sustainable development. From 2015 to 2019 the progress on the SDG Index averaged 0.5 points a year. This rate was too slow to achieve the SDGs by 2030. Progress also varied significantly across countries and goals, with trends for some countries and some goals heading in the wrong direction (Sachs et al, 2022).

Overall, progress on the SDG Index has stagnated across all income groups. The decline in the SDG Index score since 2019 has been driven primarily by a reversal in progress on socioeconomic goals, which have been impacted by the multiple crises during this period (Sachs et al, 2022).

Lebanon, a low-income country, was ranked 97th with an overall score of 66.3, which exceeded the SDG index score by a narrow margin (Sachs et al, 2022).

Table 1 sourced from the report of the United Nations, presents the status of Lebanon's state of progress on the 17 SDGs.

Table 1: SDG's Country Profile: Lebanon (UN,2022)

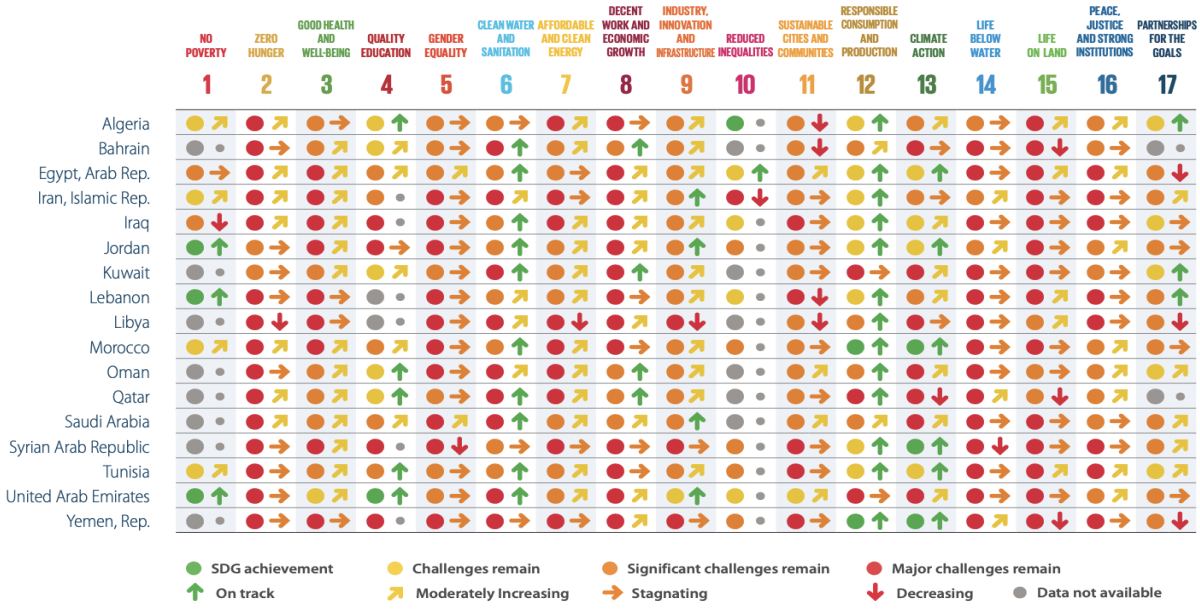


Table 1 Shows:

- 1 SDG decreasing in performance related to major challenges (SDG 11),
- 2 contained no data for assessing progress (SDG 4 and 10)

- 6 stagnating performances mostly due to social and economic challenges (SDGs 2,3,5,8,14,16)
- 5 moderately increasing as various challenges remain to hinder SDG attainment (SDGs 6,7,9,13,15)
- 3 are on track for achievement (1,12,17).

Developing States such as Lebanon tend to face the largest SDG gaps as shown in figure 8 below:

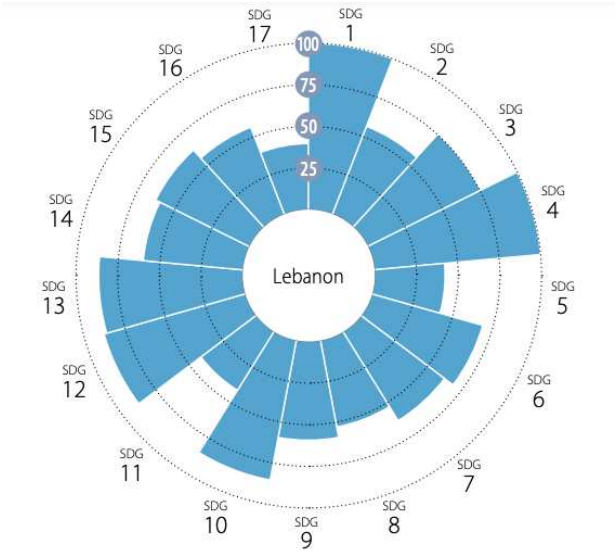


Figure 8: Lebanon state of art in view of SDG's (UN,2022)

This is largely driven by a lack of the physical, digital, and human infrastructure needed to achieve the socioeconomic goals and manage key environmental challenges (Sachs et al,2022).

3.2. Contextual Analysis

A country, predominantly mountainous located on the eastern shore of the Mediterranean Sea with a coastline expanding over 225 km, Lebanon is 10,452 km2 with a population of approximately 4 million.

Since the 1975 - 1990 civil war, the Lebanese territory has witnessed progressive fragmentation coupled with demographic and socio-political expansion. The regional instabilities since 1990, Iraq, Kuwait, and Syria, have exacerbated the internal divisions and consequently disproportionate urban dispersion.

Lebanon is classified as an upper-middle-income economy and one of the wealthiest economies in the South Mediterranean region, with a GDP per capita exceeding $11,000 in 2015. Yet it

continues to face challenges in translating relative financial wealth into socioeconomic progress for its people, with significant regional disparities and dispersed pockets of extreme poverty (UNHCR, 2016).

Lebanon has one of the highest levels of debt in the world (as a percentage of GDP). In 2015 and 2016, the total government debt which had stabilized at 133% of GDP in 2013 and 2014, rose to 138% in 2015, and 144% in 2016 (World Bank, 2018). This deterioration is due to weakening public finances, partly owing to a higher debt service burden and expansionary public spending, in addition to low real growth negatively reflecting on tax revenues. In the absence of fiscal adjustment, debt dynamics will worsen further in an environment where global interest rates and oil prices are expected to slightly rise, translating into higher transfers to the loss-making electricity company and a further worsening of Lebanon's interest payments (World Bank, 2021).

Up to 2010, the country witnessed four years of strong economic growth at an average annual rate of 9 percent, led by high investment rates and a strong service sector. However, the political instability and deadlock preceding the election of President Aoun on the 31st of October 2016, combined with spillovers from the Syrian conflict and lack of reforms including a serious waste management crisis contributed to the declining trends in confidence which is continuing to weigh on growth prospects (World Bank, 2020).

The Syrian crisis is also having a profound impact on social stability in an economy that was already facing many difficulties. According to UNDP's internal estimates, the conflict is likely to have cost Lebanon $5BN in lost economic activity throughout 2012-14, less than the $7.5BN loss previously estimated by the UN and WB as part of the Economic and Social Impact Assessment conducted in September 2013(CIA, 2015). Furthermore, refugees are also thought to have affected the labor market. The unemployment rate, which stood at 9% back in 2012, is estimated by ILO to have gone up to 12% due to the influx of refugees in 2014. In addition to raising the informality in the economy, which was thought to be relatively high in Lebanon well before the Syrian refugees' influx (World Bank, 2017).

Moreover, the presence of Syrian refugees had a mixed impact on the fiscal position, indirectly weighing on universally provided subsidies (such as electricity, bread, wheat, and gasoline), and exerting a modest positive influence on some revenues (such as property taxes).

On the environmental front, Lebanon has rendered the achievement of MDG 11 on shaky grounds as environmental problems concerning land use fragmentation and natural resources depletion

have yet to be addressed (World Bank, 2021). Lebanon has formulated environmental laws and decrees drafted but much less enacted such as:

- Law 78/2018 on the protection of air quality comprises 34 articles related to ambient air pollution monitoring air pollutants, assessment of their level in the Lebanese atmosphere, prevention, control, and surveillance of the ambient air pollution resulting from human activities.
- Law 444/2002 on the protection of the environment, the air quality, and control of unpleasant odors.
- MOE decision 8/1 dated 01/03/2001), MOE Decision 52/1 dated 12/09/1996 covering national ambient air quality standards for Lebanon.
- National strategy for air quality management 2015-2030
- The Lebanese government signed and ratified the UNFCCC in 1994 as a non-annex 1 country.
- Decree 8941/2012 CoM approved the draft law which aims to incentivize the public transportation sector.
- Law 243/2012 New traffic law.
- The Policy paper for the electricity sector (PPES) which seeks to redress the country's ailing electricity sector by 2015 and achieve the 12% renewable energy contribution
- The national energy efficiency action plan (NEEAP) tackles energy efficiency in electricity generation, transmission, and distribution.
- The national renewable energy action plan (NREAP) is the main national document that will lead the way for Lebanon to develop the different renewable energy technologies needed to reach the 12% target by 2020.
- Strategic environmental assessment of the oil and gas sector.
- 132 / 2010 oil and gas activities
- Degree 10289 2013 petroleum activity regulations
- Ministry of environment circular 11/1 2013 operations of electric generators
- Policies and legal framework and the municipal solid waste sector
- 2010 strategy for SWM according to CoM decision 55/2010, dated 01/09 / 2010
- The 2013 Draft of the national master plan 08/2018 on integrated solid waste management and master plan for solid waste management

The ability of the Ministry of Environment (MoE) and other involved ministries and intergovernmental agencies to enforce environmental regulations has proven to be weak and

ineffective, reshuffling of ministerial cabinets is affecting the planning and the work of the MoE leading to the discontinuation of the National Environmental Action Plan (UN, 2016). Moreover, the government is failing to convene regularly, a fact that prevents them from addressing pertinent challenges in a timely fashion.

3.3. Sustainability in Construction Projects

3.3.1 The Lebanese Economic Structure

Lebanon's economy and markets are best described at the dawn of the new millennium by a private and liberal economic activity and openness to abroad, with perfect capital and labor mobility. The private sector contributes to around 75% of aggregate demand, a well-diversified sector that covers the totality of economic sectors and is a major pillar for growth and recovery (Lebanese Embassy, 2020).

Lebanon has reconstructed its infrastructure, with 80% of the basic infrastructure rehabilitated using the best technologies. Furthermore, the government has revised most of its business laws and regulations and has a reputable banking sector with high financial standing, strictly regulated by the Central Bank (World Bank, 2019).

Moreover, Lebanon has initiated a process of domestic capital market development, frequently accessed international markets, and recently launched in-depth growth-oriented measures aimed at stimulating the economy (IMF, 2020).

Lebanon's liberal economy is built on competition and private ownership. Services and banking sectors predominate, representing 70% of the country's gross national product. Agriculture constitutes 10%, and the industrial sector makes up the remaining 20% (FactFish, 2018).

3.3.2. Construction as a pillar of Lebanon's economic structure

The real estate market in Lebanon is one of the economic pillars where the sector contributes to nearly 15% of GDP (from nearly USD 8 billion in 2015 to USD 8.4 billion in 2016, an annual increase of 4.9%). Furthermore, real estate registration fees stand at nearly 8% of public revenues as of end-2016. Public revenues generated from the real-estate sector fees stand at more than 11.6% of total government revenues. Growing challenges arise through high prices of land and Foreign Direct Investment (FDI) negatively influenced by the unstable socio-economic situation (Bank Audi, 2021).

3.4. The Construction sector in Lebanon: the bloodstream for investments

Prior to the conflict, the property sector had always been important, with a substantial portion of the activity concentrated in Beirut, as the housing needs of the city are rapidly increasing, urban population had to be met. Beirut saw an almost uninterrupted boom from the late 1950s to the early 1970s, when it expanded dramatically, eventually to house half of the country's population. Mountain towns and villages close to Beirut favored by tourists, such as Aley and Bhamdoun, also experienced a boom (UNHCR,2018).

The post-conflict era has witnessed a significant construction boom. Real estate prices have risen steeply, especially for prime property, but have recently stabilized. The boom has been fueled by a mixture of local, expatriate and Gulf Arab funds. (Lebanon Embassy, 2019).

3.4.1 Construction sector in Lebanon: From regulations to implementation

The construction process in Lebanon involves many steps, from pre-design to occupancy and decommissioning. The pre-design phase of the development project is where project managers, architects, civil engineers, managing directors, chairmen, and investors meet to set up the scope of work. Then the architects, structural, civil, and mechanical engineers convene to draw up the construction plans taking into consideration the Project requirements and specifications (Project Management for Construction: The Design and Construction Process, 2019).

After the plans have been drawn up, the team requires a permit to implement the project. As such, the engineering committee will submit their plans to the order of engineers to be approved by either the Director General of Urban Planning and/or municipalities.

All through this process, different levels of interventions and decision-making can take place in relationship with the variable stakeholders' influence, which impacts the project’s quality and cost concerns to different degrees. One such implication is environmental compliance and regulations since it can affect construction management. Moreover, bribes and corruption of many sorts are embedded in the bureaucratic Lebanese construction system, entailing a lot of weaving back and forth between construction activities.

3.4.2 Environmental considerations in construction in Lebanon

Lebanon has been under reconstruction since 1990 after a decade and a half of a civil war that ravaged its infrastructure, economy, and environment. In an attempt to renovate the infrastructure and revitalize the economy, the government has implemented several projects and focused on capitalizing on tourism and other avenues. On the environmental level, however, not much has been done, except the new aforementioned environmental decrees. However, the private sector, since the year 2012, spearheaded by the OEA and other stakeholders-initiated awareness campaigns and other forms of education mediums, highlighting the importance of preserving and enriching the Lebanese environment. This is exemplified by the OEA incorporating the Green Building initiative in its awareness campaign, first through a seminar on green buildings with the Swiss embassy titled Swiss Positions: 33 takes on sustainable approaches to Building in 2012 and then in 2014 with a committee formed by the Order of Engineers & Architects in Beirut to develop the national criteria for green buildings, resulted in the Green Book published in 2017.

Aside from the incentive plan launched by various international and national players through Lebanon's central bank through NEEREA and LEA financial mechanism, subsidizing partial loans at 0% interest to developers of energy-efficient real estate projects, there has been very little support from the government. No law in Lebanon pushes for green buildings yet, and development decisions so far tend to rely solely on financial incentives and the ups and downs of the real estate market.

However, in June 2011, the Lebanon Green Building Council (LGBC), with support from the International Finance Corporation (IFC), a member of the World Bank Group, launched the national ARZ rating system, created to evaluate the energy efficiency of commercial buildings in the country, to encourage better resource management, decrease energy costs and address climate change.

3.5 Situational Change in Lebanon

This research is a snapshot of time, taken between 2017 and 2018. Lebanon has undergone severe changes since 2017 with emphasis on years from 2019 going forth. Economically, the unprecedented hyperinflation and currency devaluation led to negligible purchasing power and a

decrease in investment opportunities. Socially, due to economic and political turmoil, the Lebanese people have been demoralized and kicked back to sustaining psychological and physiological needs.

1. Political instability: Civil war and numerous changes in administration are only two examples of Lebanon's lengthy history of political instability. Long-term policies and efforts, such as those pertaining to green building, are difficult to put into action because of this volatility.

2. Economic difficulties: Due to rising inflation, a high debt-to-GDP ratio, and a depreciating currency, the Lebanese economy has been battling in recent years. The building sector finds it challenging to invest in green practices and technology as a result of these economic difficulties.

3. Limited resources: Water and electricity are two examples of Lebanon's limited resources. In order to lessen the demand on these resources, it is crucial for the building sector to adopt sustainable methods.

4. Lack of regulation: At the moment, Lebanon has few laws governing environmentally friendly building methods.

The COVID pandemic that broke out in 2020, prioritized health in peoples' mindset. Politically, severe change has happened as a result of the August 4, 2020 explosion, one of the worst

explosions in human history. It resulted in the death of more than 200 victims, the displacement of thousands, and destruction worth billions of dollars.

As a result of those negative macro-environmental factors, industries in their entirety have been negatively affected. The construction and real estate industries have been severely affected. As bad as it may seem, this environment poses an opportunity if looked at from an optimistic frame of mind, along with applying existing environmental laws and sustainable construction standards prevalent in stakeholders such as the Order of Engineers and Architects (OEA) and the Lebanese Green Building Council (LGBC).

Due to the relatively high concentration of green buildings in Beirut and its proximity, and as a result of the unfathomable explosion that occurred on the 4th of August, this research can aid in providing a pathway to reconstruction and renovation through understanding the roles and responsibilities of inferential stakeholders in gearing towards sustainable construction.

Figures and facts were formulated and created before 2019, however, this thesis's recommendations are still pertinent as opportunities are prevalent in this current state to build on.

Summary

This chapter outlined the contextual analysis of the thesis by highlighting Lebanon's position with respect to the SDGs, elaborating on the distinctiveness of the Lebanese context, illustrating the economic structure, and emphasizing the construction part as it forms a pillar of the economy. Furthermore, this chapter also focuses on the Lebanese construction process, underlining it from regulations to implementations of how a construction project works, addressed the environmental consideration in Lebanese construction, and ended with focusing on the situational change that Lebanon is currently undergoing.

Chapter 4: Methodological Approach: Identifying stakeholder and Construction flow Nodes

This chapter presents the methodological approach followed throughout this research to identify stakeholders involved in construction projects in Lebanon and to highlight the various nodes along the construction flow that would serve as a leverage point to orient and guide sustainable construction.

Section 1 builds on Saunders's research onion, elucidates the data collection methods utilized, and presents research limitations. Section 2 highlights the tools used in compiling and evaluating data, starting with information systems aids undertaken, predominantly Social Network Analysis (S.N.A) and Geographic Information Systems (GIS). Elaborating on how and why those tools were implemented and their fit within the context of the research

4.1. Research methodological choices

Building on Saunders et al. (2003), this section describes the overall research strategy of this thesis, of which the research timeframe, choice, strategy design, and philosophy issues are a subset.

The research process "onion" (Saunders et al., 2003:83) provides a clear and comprehensive structure for describing the various choices that were made in this research.

The research design encompasses the strategies, plans, and steps adopted to answer the research questions (Tan 2002). It is important to form a base for meeting the established research objective, which, in turn, helps to answer the research questions. Generally, research design involves a series of choices. The two most fundamental of these are stating exactly what is to be studied and determining the best approach to do so (Babbie 2013). Other important decisions include the type of sample and methods of data collection to be used, how the variables are to be measured and how best to analyze the research concepts and variables (Cavana et al. 2001).

Based on the knowledge gained from the literature review, the theoretical framework was developed and subsequently interpreted to develop a series of results.

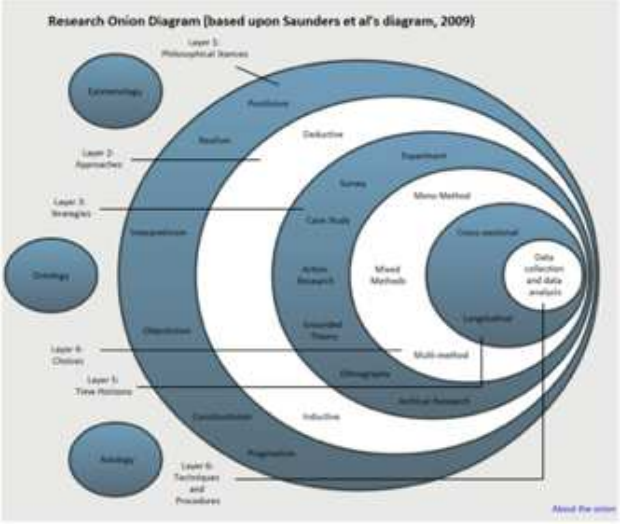


Figure 4: The research onion diagram based on Saunders et Al's, 2009

This data is subsequently interpreted by the researcher and placed into a diagram that reflects the choices pertinent to the research at hand and interworks between the concepts laid by Saunders.

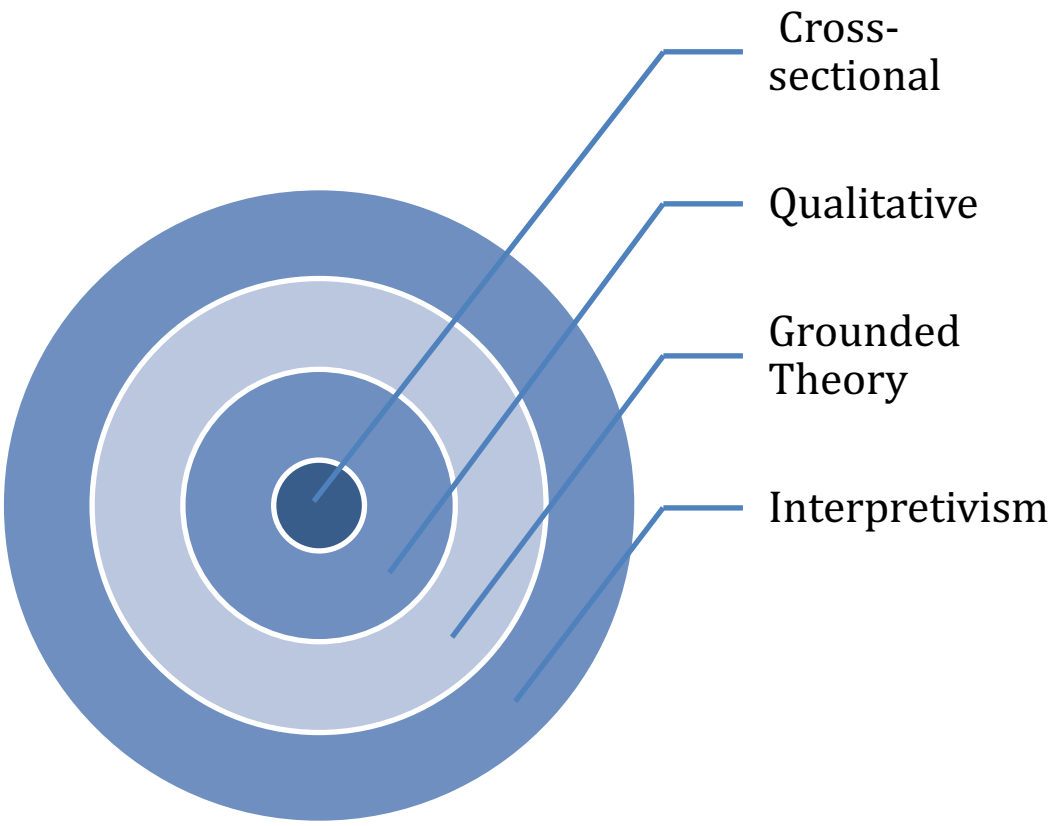


Figure 9: Research Framework choices adapted from Saunders 2009

In order to answer the Research questions and meet the objectives of this research, the methodology has followed a cross sectional time horizon along with a mono method choice compromising of qualitative data analysis. Pertinent strategic research choice was grounded theory with an inductive approach and an interpretivism philosophy.

Longitudinal studies study a phenomenon over a long period of time, while cross-sectional studies study a phenomenon at a particular time (Saunders et al., 2003:96). This research is suitable for either a longitudinal or cross-sectional study. Stakeholder management activities are easily identifiable: Multiple discrete events take place during project execution, which makes them suitable for a longitudinal study. At the same time, because they are discrete events, stakeholder management activities can be studied in a cross-sectional context. This research studies the

influence of stakeholders on the quest for sustainability in a cross-sectional context for various practical and theoretical reasons.

An important reason that influences the decision for a cross-sectional study is that the research investigates the relationship between stakeholder management and a green approach. The green approach can only be determined after the stakeholder has decided to shift. It is, therefore, practical and appropriate to measure after the decision has been taken. In addition, this research aims to find generalizations, deeming a longitudinal approach that often requires significant time per case unsuitable. Furthermore, a longitudinal approach does not match well with an experimental setting due to the difficulty and near impossibility of leveling and controlling variables that may influence the results.

Monomethod qualitative has been undertaken, building on qualitative data collection and analysis. Qualitative Research is often used as a synonym for any data collection technique or data analysis procedure that generates or uses non-numerical data Qualitative research studies the participants' meanings and their relationships using data collection techniques and analytical procedures to develop a conceptual framework.

Qualitative research is associated with an interpretive philosophy (Denzin and Lincoln 2005) which requires researchers to make sense of the subjective and socially constructed meaning expressed by the phenomena being studied (Saunders, 2016). Saunders defined Interpretivism philosophy as an epistemology that advocates that the researcher needs to understand the difference between humans in their role as social actors. Thus, "actors play a part which they interpret in a particular way and act out their part per this interpretation" Moreover, the research approach tends to be inductive when using qualitative means of data collection, clarifying the researcher's choice. "Many varieties of qualitative research commence with an inductive approach" (Saunders et al, 2016).

The exploratory character of the research is illustrated by the study of relationships between stakeholder power and impact on sustainable construction adoption. The results do not aim to test the theory but to provide more insight into the relationship between stakeholder management and sustainable construction.

Data collection is the pivotal step in research since the data collected provides the base for a problematic potential outcome. To collect all the relevant and essential data within the limited time

frame, we used different data collection mediums, including face-to-face interviews, telephone interviews, computer-assisted interviews, emails, websites, the internet, journals, and books.

The main strategy we used for collecting information was primary data, specifically, interviews in different types and forms. The most important aspect of primary data collection is that it provides the researcher with original, unbiased data. It is reliable and focuses on specific areas of interest, making it easy for users to control the type of data they collect(Saunders,2009).

Primary data is collected through direct or indirect mediums of communication, such as interviews, questionnaires, and surveys. “Certain other types of information are best obtained by observing events, people, and objects, or by administering questionnaires to individuals. Such data gathering for research from the actual site of occurrence of events is called primary data.” (Sekaran and Bougie, 2013).

However, interviews were the most relied-on data collection method for this research, as they allowed the researcher to address arising issues, and quickly analyze the situation. Interviews were conducted by the researcher within the private networks first, to identify the stakeholders and obstacles that can affect the project, whether positively or negatively. The interview is a common occurrence in social life because there are many different forms of interviews.

Starting with unstructured interviews, the objective behind them is to bring some preliminary issues to the surface so that the researcher can determine which variables require further in-depth investigation.

To understand the situations requiring unstructured interviews with the people concerned, as well as, the situation in its totality, the researcher should interview employees at several levels. In the initial stages, only broad, open-ended questions were asked, and the replies informed the researcher of the perceptions of the individual. Refer to the appendix for a detailed depiction of the interviews conducted.

This process paves the way for structured interviews. These will be concerned with the variables, their effect, and their origins, and lead to the discovery of the main variable that is driving the main problem the researcher is trying to solve. Structured interviews are usually conducted after the researcher has completed a series of unstructured interviews that determine the distress factor. Structured interviews are conducted when the interviewer knows beforehand the variable or anomaly and wants the interviewee to answer specific questions specifically designed to provide information or a solution to the problem at hand (Saunders et al, 2009). Interviews were conducted

with pertinent stakeholders. Interviewees were asked questions about the various processes and decisions pertaining to construction projects. Followed by the degree of ease of accessing information and the main motives/goals for building a green or non-green project. The weighting of the edges between each pair of stakeholders was quantified based on two aspects: the ease of reaching information and the common interests/goals, the common goal of the clients, certifiers, and engineers is to ensure compliance with the regulation.

After conducting a multitude of structured interviews concentrating on the issues identified by the unstructured interviews and acquiring the necessary information to provide a solution for the problem, the researcher stopped. Afterward, the researcher set out to identify means to tackle the problem and end up with a conclusion.

Secondary data is another form of data collection used in this research, it is collected from various mediums such as journals, articles, and the internet. “They are the data that already exist and do not have to be collected by the researcher” (Sekaran and Bougie,2013).

Certain types of information such as the background details of a company or entity can be obtained from available published records, websites, archives, and other sources. Other types of written information, such as government policies, procedures, and rules, can be obtained from government records and documents.

Interviews were conducted to collect primary data from the relevant stakeholders at different levels and various power positions. Unstructured interviews were first conducted to explore the phenomena and realize where answers are found, as it is the first step in gathering information

4.2. Research limitations

Self-reported data is limited by the fact that it can rarely be independently verified, due to the utilization of a qualitative research study and having to take what people say at face value.

Furthermore, self-reported data has various sources of potential biases such as selective memory, telescoping, attribution, and exaggeration.

After completing the interpretation of the findings, the way data was gathered inhibited the ability to conduct a thorough analysis of the results and triangulation using quantitative analysis. In retrospect, this could have helped address some issues about the different stages in the construction process lifecycle. This can open a door for future researchers to revise and utilize various methods

for gathering data, as these limitations can serve as an important opportunity to identify new gaps and describe the need for further research.

4.3. Information System Tools Utilized

Data collection source varies depending on whether a quantitative or qualitative research approach is adopted. When using the qualitative approach, data collection tends to rely on instruments such as observation of participants, interviews, focus groups, or language-based approaches (Bryman 2012). Researchers should carefully select the appropriate instrument, as it is important to collect the data that most closely fits the research problem and answers the research questions (VanderStoep and Johnson, 2009).

The Methodological approach adopted in this research builds on multiple Information system tools to develop the results. Research questions posed at the beginning of the research provided a guiding direction and influence to the network by directing the data collection process and methods of data analysis. The research questions stem from an exploratory one, which aided in understanding the composition and function of the network. Furthermore, allowing the researcher to understand intervention in the network or evaluate the impact of network inference. Using conventional software packages proved to be rigid as a result, Gephi Version 0.9.3 open-source, I. Draw version 5.2 open source and OmniGraffle version 7.18.1 Trial were utilized exhibited in the table below:

Table 2: Software utilized

Software		
ArcGIS	Used to display geographic data obtained from primary and secondary data.	explore and understand the spatial distribution and clustering of green buildings in Lebanon.

Software		
 	Exhibit the construction flow	Specify the construction Stakeholder importance highlighting the intricate relationships and responsibilities each has in the various phases of construction.
 	Identifying and understanding the type of relationships between the construction stakeholders.	Identify stakeholders who are most connected and influential in the construction project. Understand their capabilities in shifting decisions based on their authority levels to gear for green construction.

Formulating a Network basis was founded on stakeholders involved in the construction process as a whole. The list of stakeholders and type of interactions were based on compiled primary and secondary data. Allowing the researcher to understand the kind of information, type, and pertinence to the decision-making process.

4.3.1. Social Network Analysis

One of the traditional methods of analyzing stakeholders is to prioritize their influence on the outcomes of an organization/activity, based on their possession of certain attributes such as power, legitimacy, urgency, knowledge, interest, and so on (Turner,2006). Social Network Analysis (SNA) presents an approach for identifying the degree of stakeholders' influence based on their centrality metrics and position within a network.

Social network analysis is a strategy for investigating the degree of influence (using centrality metrics) of each actor within a network, how they can impact each other's behaviors, and the level of connectedness, cohesion, and clustering within the network as a whole (Otte E and Rousseau R., 2002). The analysis of the network structure is accomplished by following graph theory and social network notions (Loosemore, 1998). Stakeholders with high centrality aspects are more likely to influence others and have higher power within the network.

Multi-criteria decision-making methods deal with decision problems under the influence of several criteria (Pohekar and Ramachandran 2004). An example of these methods utilized was I. Draw and Social network analysis using Gephi.

The SNA combines qualitative and quantitative components in one technique: the qualitative component decomposes the unstructured problem into a systematic decision hierarchy, while the quantitative component is the numerical weights from the Centrality and In-betweenness measurements (Cheng and Li 2001b). SNA has been widely used as a multi-criteria decision-making tool, due to its flexibility and its ability to solve more complex forms of network-related problems. SNA principles are used in analyzing the network that exists in a construction project, as a demonstration of how SNA can contribute to the identification of stakeholders' contrasting influences on the stakeholder's choice of pursuing a conventional or sustainable construction.

The shared interest and means of communication through the aid of Gephi's heat map and network analysis were either quantified based on the answers of the interviewees or inferred based on the common practice of stakeholders who were not interviewed.

All the edges in this study are undirected since the main aim is to identify the degree of communication/links between stakeholders regardless of the type or direction of information flow between them. The data gathered were used to generate a stakeholder network using Gephi network analysis and visualization software. Gephi is open-source software that has been used by many researchers to analyze networks in various fields such as construction management, animal behavior, social media, and politics. To understand the relationships and connections between individuals, groups, and objects. It is an open-source platform that provides a simplified approach to social network analysis enabling the researcher to understand who is working with whom, the diffusion or acquirement of information, and the concentration of power within special interest group form and function (Gephi, 2021).

It has been applied to explore data through intuition-oriented analysis by network manipulation in real time, revealing the underlying structures of association between objects and their relationships. Gephi is a tool for data analysts and scientists keen to explore and understand graphs. The user interacts with the representation and manipulates the structures, shapes, and colors to reveal hidden patterns. The goal is to help data analysts to make a hypothesis, intuitively discover patterns, and isolate structure singularities or faults during data sourcing (Gephi, 2021). In addition, creating a social network that the researcher analyzed facilitates the creation of social data connectors through mapping community organizations and small-world networks.

4.3.2. Geographical Information Systems

Secondary data was compiled on green-rated buildings in Lebanon, aiding the researcher in identifying spatially the relative closeness and distribution of rated and pending green buildings in Lebanon using a Geographical Information System.

Geographical Information Systems (GIS) technology is used by geographers, archaeologists, geologists, and a wide range of others in the social and natural sciences for storage, manipulation, and mapping of data with a spatial reference. (Gunasekera, 2004). It is a computer spatial system for capturing, storing, checking, and displaying data related to positions on Earth's surface. By relating seemingly unrelated data, GIS can help individuals and organizations better understand spatial patterns and relationships. (ESRI, 2021)

GIS connects data to a map, integrating location data (where things are) with all types of descriptive information, this provides a foundation for mapping and analysis utilized in numerous industries. GIS helps users understand patterns, relationships, and geographic context (ESRI, 2021).

GIS, coupled with tabular data known as attribute data, is a map of various green buildings certified or in the process of being certified by national and international Green Rating systems applicable in Lebanon. Enabling the researcher to display the building’s actual location, as well as additional information about each of the spatial features, in a map form. Green buildings distributed in Lebanon were labeled according to their adopted green rating system, criteria, and status showing the LEED, BREEAM, and ARZ rating systems. Furthermore, it showed the status of whether a rating has been given or is pending, and the rating scale achieved or aimed at for each construction project.

Allowing the researcher to analyze the potential of gearing sustainable construction practices in Lebanon and choosing the best route through spatial analysis (Dempsey, 1999).

4.4. Data Collection Approaches

Various information system tools were utilized to make sense of the primary data compiled. I. Draw was used to construct the graphs and figures to illustrate the construction process along with depicting the work breakdown structure of the construction project. Identifying where and how stakeholders can intervene and shift the process from conventional to sustainable.

Each step is color-coded, and identifiable shapes relative to the construction stage are adapted, facilitating the comprehension of the segmented stages, and enabling a visual understanding of the process through clear labels.

Multiple interviews conducted with LCEC members through various mediums of communication lead us to include key stakeholders such as banks, etc. in the equation. Furthermore, construction developer Antoine Damous helped us understand the inner workings of political negations and conflict resolution between clients and stakeholders. He also highlighted the importance of including the government in our analysis. Another visual tool that enabled us to illustrate some of the findings of interviews was OmniGraffle, which was pivotal at the beginning in identifying the key stakeholder interactions pertinent to particular project management stages.

Understanding the interactions between stakeholders enabled the researcher to pinpoint key players that can have a favorable or diverse effect on the outcome of the project based on the impact and power they have.

Finally, compiling all the information from the interviews conducted and uploading them on Gephi was the last information system tool adopted. It was utilized to construct the network between stakeholders conventionally and sustainably, allowing the researcher to analyze the different approaches stakeholders leverage and the power shift occurring at different ends of the spectrum, as well as their role change in milestones and key activities.

In this research, a total of 16 respondents participated. They were identified by the researcher and co-thesis director's contacts, and then by using snowball sampling. Their expertise and multirole are in managing and impacting construction projects in Lebanon (refer to the appendix.)

As shown by the respondents' profiles, participants were selected based on their job position, type, and background. Most participants were project managers or construction general managers,

assessors meaning they knew about managing conventional and green construction projects. Additionally, they had experience in the construction industry and building projects specifically, making them able to identify the stakeholders that should be involved in defining the project and elicit their importance to each element in the project initiation. Moreover, most respondents had technical, social, and management experience.

Summary

This chapter outlined the research methodological choices and limitations, including the main source of data for this study; that is, multivariate forms of interviews such as face-to-face, telephone, emailed unstructured, and semi-structured interviews. The data collection activities, instruments, respondents' profiles, and research objective outcomes were also detailed. Purposeful sampling was selected as the appropriate sampling strategy for all phases of the research, and respondents were selected based on their job position, work experience, background knowledge, and stakeholder category. The sample size was small, but this does not invalidate the findings as it is adequate for this type of study. This is because the study uses Social network analysis and other forms, which are not traditional qualitative data analysis methods; they are techniques in which statistical sampling is not the issue in all circumstances.

This chapter presented the profiles of the respondents for all phases of the study, including the steps within each phase. Furthermore, it explained how the developed research questions would be answered and discussed the data analysis strategies required to achieve the research objectives. This chapter also discussed the use of information system tools and techniques, as used in a variety of contexts in many areas of construction project management research. Further details and results of the relevant analysis undertaken in this study are presented in the following chapters.

PART 3: Results

This part presents the research results obtained through data collected on and off the field. Interviews and other forms of information made it possible to grasp the Lebanese construction particularities and identify state of art sustainable approaches and future potential. This part is organized into 2 chapters; chapter 5 will address the readiness of Lebanon for initiating a smart city concept as well as a green neighborhood. Chapter 6 will analyze the qualitative data collected and answer the research questions in relation to how stakeholders impact project milestones, which should make it possible to understand the process of information exchange, and the stakeholder's role in developing sustainable construction. Furthermore, it will address the tipping points in the construction projects that shift the construction from conventional to green.

Chapter 5: Understanding the challenges hindering Lebanon towards sustainable Construction

In recent years, many initiatives have been developed under the smart city label in a bid to provide a response to challenges facing cities today. The concept has evolved from a sector-based approach to a more comprehensive view that places governance and stakeholders' involvement at the core of strategies. Stakeholders' involvement in both the project and the city strategy, is the key to formulating a smart vision.

In this section, an evaluation of the current situation in Lebanon Vis à Vis a smart city is presented, followed by the analysis of green opportunities in Lebanon.

5.1. Smart cities in Lebanon- an achievable goal?

A Smart City requires integrated policies, systematic approaches in all city systems, continuous analysis and assessments through statistics/indicators, and horizontally distributed continuous monitoring. In Smart cities, national plans and programs should be evaluated according to strategic priorities with multiple dimensions, because Smart city operations and applications must be coherent with macro policies. Smart city vision also requires simplicity, efficiency in planning authorization, congruent plan hierarchy, and effective application tools. The Basis of this concept also includes a participatory and democratic society, collaboration, and governance. Smart city approaches also embrace the rational use of the common wisdom of citizens as a whole.

Reaching the establishment of a Smart city requires a solid and complex interaction between different stakeholders and in particular a strong emphasis on the role of the government as a primary contributor in realizing a smart city.

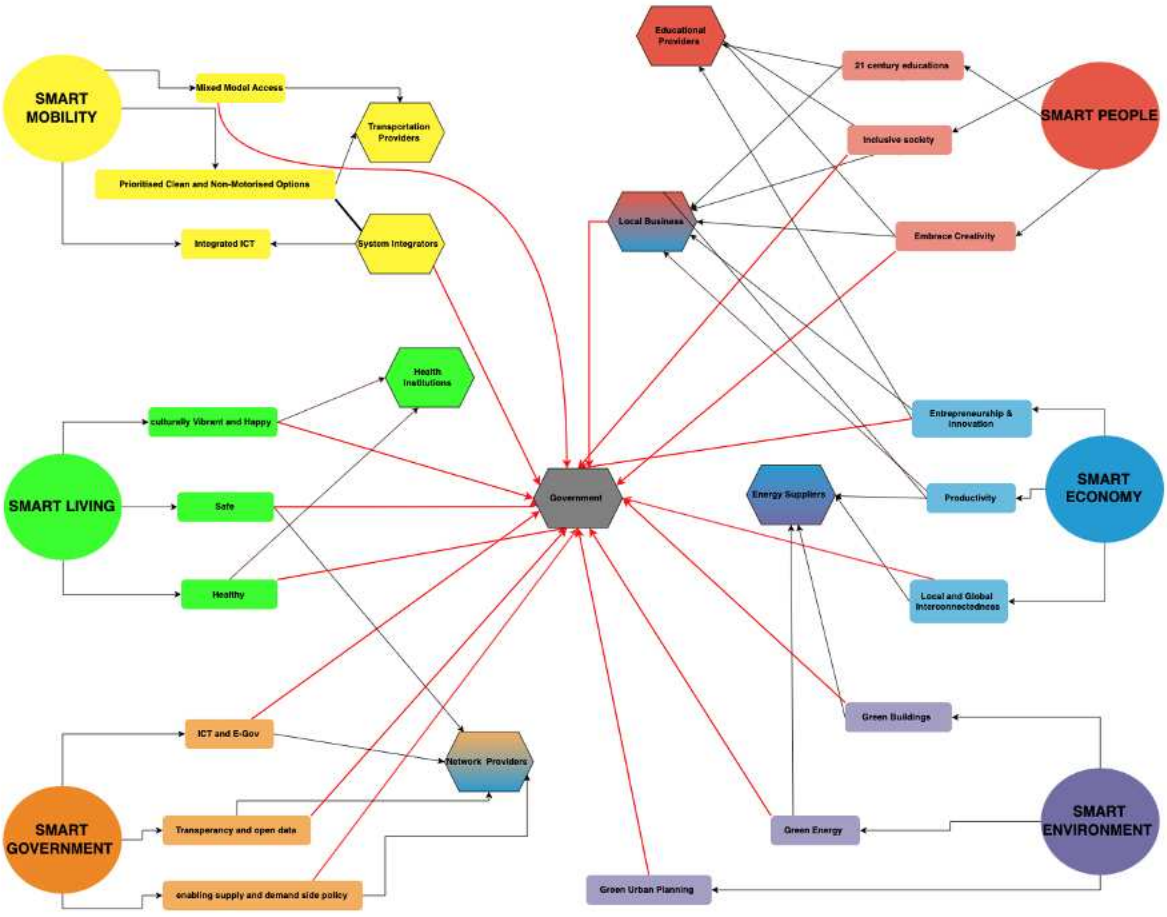


Figure 10:Lebanon State of Art pertaining to Smart city indicators adapted from Cohen 2012.

In Lebanon, the central government plays a paramount role in formulating a vision of smart strategy.

Smart city indicators prevalent in figure 9 are color-coded to represent each segment, and the arrows indicate the relationship between nodes and paths. For example, smart government is in orange and connected to ICT and E-government, transparency, and open data, enabling supply and demand side policy as indicators, whereby they are all linked to network providers. Red arrows represent the relationship nodes have with the government, allowing us to explore the intertwined relationship it has with indicators and segments of a smart city. These relationships highlight the various activities the government should be involved in to facilitate, formulate, and implement activities for a smart city concept to be materialized.

Primary and secondary interviews (appendix 1) revealed that the complexity of the interactions between the stakeholders, government, and private institutions is deficient. Highlighted in structural relationships, in particular, the absence of a unified database in government institutions where sharing and retrieving information from a single shareable source causes a partial obstruction of workflow. In addition, the bureaucratic structure and limitation of financial incentives are hindering the path toward smartness. (Kabakian, V, Khoury W, pers comm- Appendix).

Foregrounded in an infrastructure project, tendered by the government, the relationship between stakeholders must go through steps and key individuals and institutions to be implemented and delivered, resulting in multiple bottlenecks to be overcome to make the project viable (Khoury, W- 2019, Pers comm appendix).

The lack of a smart city vision from a political standpoint, budgeting, legislation, and urban planning presents a bottleneck for the adoption of smartness in Lebanon. Along with current laws and regulations exhibiting a hindrance to the quest for smart vision. Governments can either be the main facilitator or act as an inhibitor by formulating a strategy, incorporating long and short-term objectives, and identifying stakeholders' roles. Inversely abdicating from providing relevant investments funds or upgrades necessary to achieve smartness is highlighted in the national budget allocation where only a minute percentage of total public financial resources are allocated to environmental protection and sustainability (Fenianos, 2019, pers comm appendix).

Another hurdle in the mix is the relationship between property developers and customers pertaining to smartness. The demand for smart buildings is weak, due to the perceived high cost

and price skimming techniques utilized by the developers and resource providers. (Dammous, 2018, pers comm, appendix).

Figure 11: Lebanon State of Art pertaining to Boyed Cohen Smart City Wheel 2012 b.

The lack of cross-functional teams between ministries and private organizations is problematic due to absent government initiatives towards formulating a vision, mission, and strategy for implementing a smart city. Furthermore, the inadequacy of political initiatives coupled with degrading infrastructure is not a foundation on which a smart city vision can be realized. To further explore the smart city concept and its potential in Lebanon, an article was published at the MTO in 2020, with an overall objective to explore the readiness of Lebanon to adopt a smart city approach as a step towards sustainability:

"In the overall quest towards sustainability cities aim to adopt the "smart City Approach" implement private and scattered initiatives ranging from green buildings to environmentally friendly neighborhood. We wonder to what extent the green rating systems can contribute to the establishment of a nucleas towards smart cities in a complex socio-political city such as Beirut (Lebanon)" (Fenianos et al,2020).

The results were the following:

"The findings of this paper show that Green Buildings, certified under either the LEED, BREEAM, or ARZ rating systems represent an important step to establishing Smart Cities,

however, their contribution to the overall pathway towards them remains very shy. Green Rated Buildings in Lebanon confirm the emergence of environmental awareness and initial achievement in the overall quest toward sustainability. However, those are still too few and scattered to serve as a solid nucleus for the establishment of Smart Cities. Information systems notably servers, portals, and clouds are crucial in shifting from green buildings to smart buildings and in a later stage to smart environmental neighborhoods. Smart management of the urban environment is the starting point for effectively enhancing people's well-being and quality of life. Existing and pending Green rated buildings can represent a potential stepping stone towards sustainable neighborhoods where a diverse compilation of external and internal stakeholders such as retailers, NGOs, wholesalers, and neighbors collaborate on improving the living environment in which they co-exist.

The path toward Smart Cities is mainly driven or, in our case hindered by the government's will, and/or lack of infrastructure. Nonetheless, it played a multi-facet role by providing several green initiatives wrapped up under the Lebanese Central Bank, in the form of green loans. In this perspective, the Millennium development goals, in particular, SDG 11 on sustainable cities and neighborhoods can only find their full meaning in complex Mediterranean countries when it blooms from streets to neighborhoods, neighborhoods to towns and towns to Smart Cities at a later stage.

Society components such as creativity, social coherence, and well-being remain the cornerstone, and investing efforts in social and psycho-cognitive approaches as complementary tools to Information systems might pave this way sustainably. This research provides an interesting path to integrated management of city neighborhoods, which helps progressively establish sustainable neighborhoods, as a step towards smart neighborhoods and Smart Cities" (Fenianos et al, 2020).

5.2. Are Green Neighborhoods an attainable concept in Lebanon?

According to the United Nations, Lebanon is one of the most urbanized countries in the world and the Arab region. Urbanization has transformed Beirut from a tiny city to an urban megalopolis, resulting in a larger environmental footprint for urban inhabitants, thus requiring urgent attention to achieve overall sustainable development.

Beirut's urban sprawl has broadened to the degree that it has damaged natural resources in every other direction. The capital city is nearly saturated with concrete and road networks immensely burdening local infrastructure and other habitable requirements (Kabakian, Refer to the appendix, 2018). Smart city as an idea was unattainable, as presented in the aforementioned section. However, another alternative solution to urban sprawl presents itself in the form of Green Neighborhoods.

The green neighborhood concept includes the facilitation of accessibility, green network connectivity, green neighborhood buildings, neighborhood safety, highly-mixed use buildings, medium density, healthy neighborhood, suitability of design concept, time-saving and the shortening of distance to the nearest facility and public transport (Rosly, 2010). A green neighborhood is one of the most important elements in a sustainable city to increase economic, environmental, and social quality in the area.

Green neighborhoods have certain requirements, one of which is entrenched in its definition, which is a group of building blocks having green buildings, economic and cultural systems, public spaces, and infrastructure.

Starting with Green buildings, research has been conducted to identify if Lebanon has green buildings and to what extent. Results show that not only green buildings exist in Lebanon but with different rating systems with varying standards and reward systems,

Ranging from Platinum LEED to ARZ, a national rating system. Mapping of all the green buildings in Lebanon has been conducted using GIS. Mapping was done in 2018, building on the information pertinent to data available and accessible at that time. Data illustrates that only 47 initiatives have certified buildings scattered in various areas in Lebanon, with narrowing proximity in Beirut amounting to 29. A geographical analysis of the distribution of green buildings, either certified or pending as per the various rating systems adopted in Lebanon (figure 11), confirms the dispersion and relatively minimal adaptation of national and international GRS. Certified Buildings are scattered in various areas in Lebanon, however, they are concentrated in the capital Beirut amounting to 29, showing that only 47 initiatives have emerged in Lebanon since 2009.

The GIS was made as an attempt to visualize the distribution or potential clustering of Green buildings in a particular zone, presenting an opportunity to initiate a green neighborhood.

Furthermore, an analysis of their potential scalability to other cities, as a result, achieves one of the sub-elements of Cohen's smart city wheel.

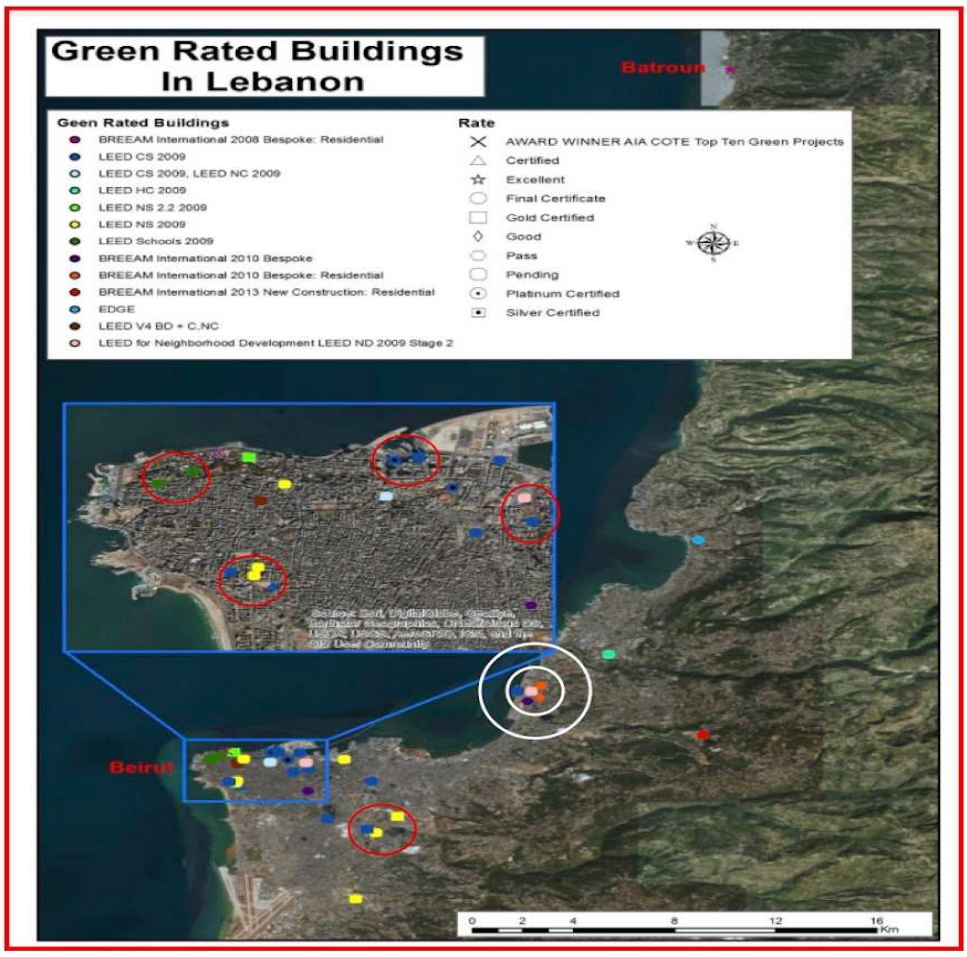


Figure 12: Green Building Distribution in Lebanon

All green buildings were identified by their rating and type of certification obtained, ranging from international standards to national ones, identifying each green rating system with colors and rating with a symbol. The spread of green buildings in Lebanon presents no viable nucleus for a green neighborhood to be incubated and presented as a potential for implementation.

Red and white circles are indicated where a couple or several green buildings are grouped together as seen they are distant from each other circle diameter reaching more than 4 km wide.

As a result, realizing a smart city or a green neighborhood is unrealistic in Lebanon as both require a greater number of green buildings with closer proximity to each other as a starting point to reach either of those choices.

The presence of Green Rated Buildings in Lebanon confirms the emergence of environmental awareness and initial achievement in the overall quest towards sustainability. However, those are still too few and scattered to serve as a solid nucleus for the establishment of Smart Cities. Information systems notably servers, portals, and clouds are crucial in shifting from green buildings to smart buildings and in a later stage to smart environmental neighborhoods. Smart management of the urban environment is the starting point for effectively enhancing people's well-being and quality of life.

Existing and pending Green rated buildings can represent a potential stepping stone towards sustainable neighborhoods where a diverse compilation of external and internal stakeholders such as retailers, NGOs, wholesalers, and neighbors collaborate on improving the living environment in which they co-exist.

Summary

The analysis carried out led us to the exploration of the readiness of Lebanon given the smart city concept.

Smart cities require readiness in terms of policies, national plans, and programs that require a solid strategy which Lebanon has not yet formulated, furthermore, addressing the components of smart cities helped in identifying workable milestones in which Lebanon has building blocks. One is green buildings, which aided in constituting an exploratory framework to address the potential shift towards green neighborhoods. Primary and Secondary data confirmed that even though the presence of green-rated buildings exists, Lebanon is underperforming on many other fronts, rendering the formulation of a smart city challenging.

Chapter 6: Gearing Green Building Construction: Role of Stakeholders

This chapter will present the state of the art of existing green buildings in Lebanon, exhibiting the various national and international standards adopted in green construction. Starting with comparing the various national and international green rating systems used, highlighting the uniqueness of each GRS, followed by depicting the construction process, by which various unique building projects in Lebanon are abiding, from conventional construction to the green building construction process. Displaying the various activities and tasks through the project work breakdown structure which processes, undertakes, and highlights the differences and possible shifting points. Furthermore, understand the importance of the pre-construction phase in construction as it presents the greatest benefit with minimum shifting cost. Moreover, define the role stakeholders have along the construction process and highlights the pertinence of stakeholders in the possible shift towards green construction aided by social networks constructed and analyzed on the construction processes in Lebanon and highlights the inferential stakeholders that can influence the process of gearing green construction in Lebanon.

6.1. Green Rating Systems: an opportunity towards gearing green construction?

This section presents the national and international green rating systems applied and adopted in Lebanon: LEED and BREEAM, and one particularly developed for the nation; ARZ. Those three systems are compared with respect to their suiting the Lebanese construction and adaptability to work in the set environment. Furthermore, illustrates the limitations and adaptability these GRS have, building on primary data collected from interviews with key stakeholders using snowball sampling, focusing on several criteria elucidated by the interviews conducted with adopters, assessors, and other stakeholders. Highlighting key breaking points and pinpointing milestones aiding in the shift from conventional construction to green. Figure below illustrates the research path undertaken analyzing each step along the way to reach sustainable construction.

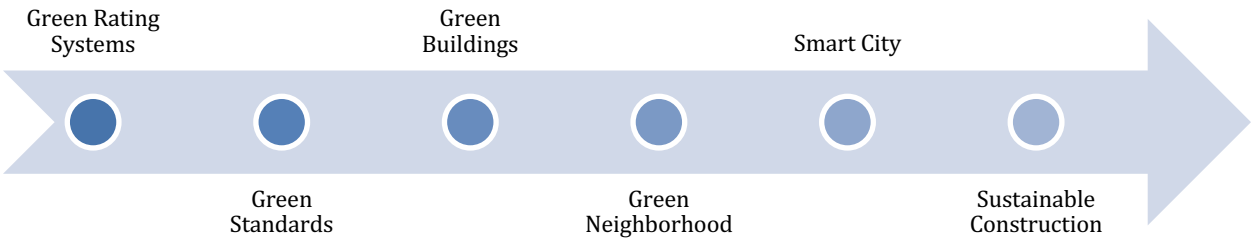


Figure 13: Research Path towards Sustainable Construction

As one of the key elements across the skyline, buildings are essential in sustainable cities. Today, cities serve as one of society's main sources of CO_2 emissions, with buildings representing almost 40 percent of the overall energy consumption throughout its various stages.

A compilation of Secondary data sources of information is used to complete a comparative matrix. That will identify the various criteria and weightings of International and national Green Rating Systems.

One of the aims of this research undertaking is to provide clarification on the various Green Rating Systems, which will help environmentally friendly investors and other willing stakeholders assess

which rating system fits the bill. The aim is to help construction stakeholders shift from conventional to green construction and aid in the process of choosing the best-suited GRS by presenting a comparative analysis.

Green Buildings are ever so present in Lebanon, 53 construction projects have or are in the process of obtaining a green certification since 2010 (fig x - the GIS map): The “M 1 building” was the first LEED platinum-certified building in 2016, a process started in early 2010. EcoCOnsulting ltd was the last tracked LEED Certified building in 2018. As illustrated in Table 2, the green-rated and pending buildings in Lebanon are following national and international green rating systems. LEED, an international green rating system, has the highest frequency, followed by BREEAM, and finally, ARZ the national one. Refer to Appendix … table ... depicting the 2018 number of pending and green-rated buildings in Lebanon.

The construction industry has seen a rise in the number of rated or pending green buildings in Lebanon (World Bank, 2018). To be considered as a green building in Lebanon, a developer according to the criteria for green buildings in Lebanon is registered or committed to seeking LEED, BREEAM, or other approved International Green Buildings certification is considered compliant.

Green Rating Systems (GRS) are not mandatory in Lebanon (Table 1), they depend on client attitude awareness and willingness to preserve the environment. GRS is booming most prominently LEED as it is more marketable and more effective in large projects which constitute a larger proportion of construction in Lebanon. ARZ is a recent national GRS (2011) applicable to domestic existing buildings thus limiting its target spectrum.

Table 3: A Comparative matrix of national and international Green rating Systems pertaining to the number of certified buildings, establishment , status and organization, (LEED, BREEAM, ARZ)

GBRS	Number of Buildings Certified	Established	Status	Organization
BREEAM	590,000 Buildings worldwide (BRE 2018)	1990	Voluntary	BRE
LEED	103,000 buildings worldwide (http://cdn.ifma.org/sfcdn/membership-documents/green-rating-systems-htg-final.pdf)	1990	Voluntary	USGBC
ARZ	<10	2011	Voluntary	LGBC

Table 4: A Comparative matrix of national and international Green rating Systems addressing the rating scheme and used in Lebanon (LEED, BREEAM, ARZ)

System	Country of origin	Rating Schemes	Certification Levels	Points or Percentage allocation
BREEAM	United Kingdom	· Communities · Courts · Education · Health care · Homes · Industrial · International Multi-residential · Offices · Prisons · Retail · Other	· Outstanding · Excellent · Very Good · Good · Pass · Unclassified	≥85 ≥70 ≥55 ≥45 ≥30 <30
LEED	United States	· Building Design and Construction · Interior Design and Construction · Building Operations and Maintenance · Neighborhood Development · Homes	· Platinum · Gold · Silver · Certified	85+ Points 60 to 79 Points 50 to 59 Points 40 to 49 Points
ARZ	Lebanon	· Existing Buildings	· GOLD · Silver · Bronze · Certified · Non-Certified	135 Points 120 Points 100 Points 80 Points <80 Points

These Green rating systems are not equivalent in terms of the main features considered by green construction. Table 5 displays the various credit ratings (schemes certification levels and Points/Percentage allocation adopted by International and national GRS. The above tables presented the findings of pertinent GRS implemented or pending.

Green building rating frameworks have been created in different nations to meet their particular necessities. While international, well-established rating systems typically are adopted early, a local model is important to assess the particular difficulties and openings confronting structures in

Lebanon. ARZ was created for the Lebanese particularities, different nations of various development laws would evaluate Lebanese structures as per factors that are outside of building proprietors' control or on models not pertinent to the country.

A building rating system is expected to set up current best practices in Lebanon and to utilize this to set principles for Lebanese green structures. This first form of the ARZ Green rating system was intended for existing business structures.

As Beirut is Pandora's Box, a building system that tackles a niche of construction projects in Lebanon is not sufficient, a comprehensive rating system should be enacted to cover various building developments. A comparison between National and International Green Rating Systems with emphasis on the ones adopted in Lebanon and an analysis of their limitations to optimal implementation in the growing local market was conducted. To better understand how GRS criteria, requirements, and implementation can help to transform Beirut's structures and the environment from its current form to greener ones.

The need for a wholesome upgrade is more petitioned than ever, encompassing the variations and ever-changing particularities of construction projects in Lebanon are in dire need of ARZ as a national green rating system. Many countries possess tailor-made GRS formulated and implemented. These systems have been employed and appraised from diverse fronts and are attuned to meet various stakeholder requirements. From governmental policies and regulations to construction developer profitability and marketability to customer green building purchasing requirements. GREEN Buildings are choices that clients choose to pursue. Therefore, in the quest towards sustainability through the frame of green construction in Lebanon, this research will explore the potential impact stakeholders may have on the decision towards gearing construction projects from conventional to GREEN. In that respect, the following section will highlight the policies to be followed by Construction Process and consequently understand the stakeholder management aspect of the project.

6.2. Construction process-an opening opportunity for transitioning to green construction.

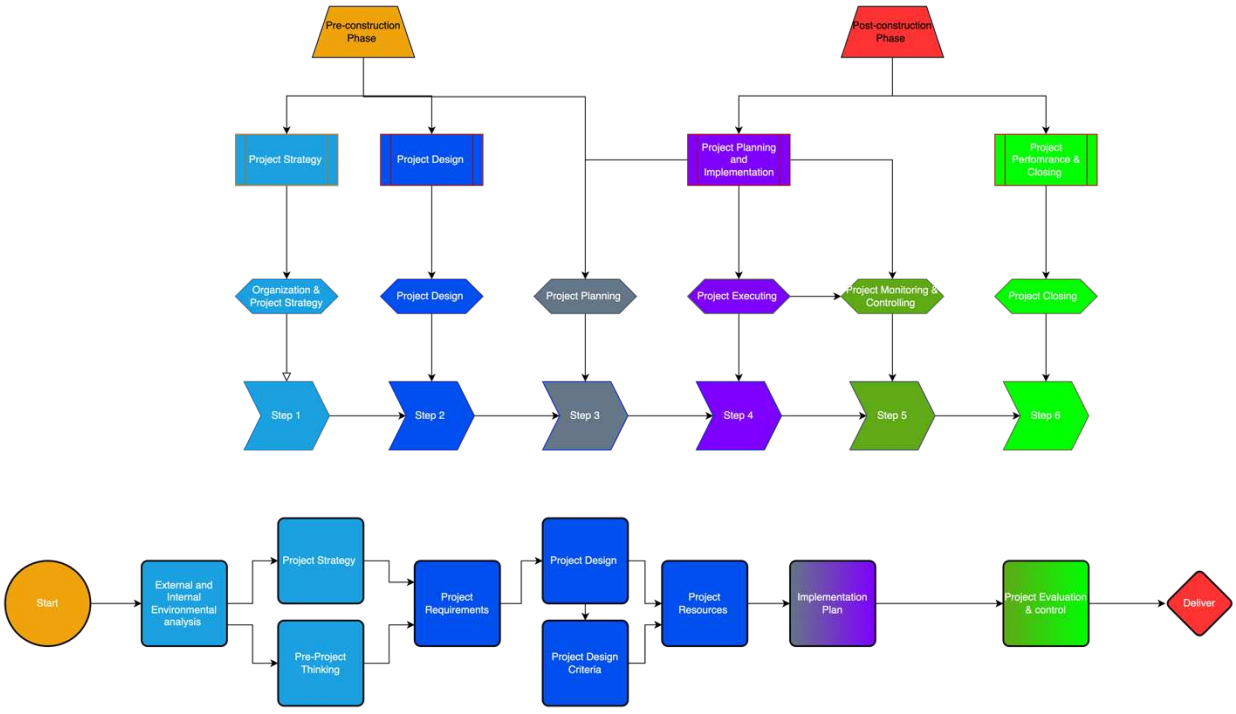
This section focuses on analyzing the construction process and identifying the most pivotal phase enabling green construction in Lebanon. Moreover, it highlights the pre-construction phase and analyzes its importance in driving toward green construction, emphasizing the steps and critical

parts accounting for a possible shift by building on primary data collected from interviews conducted with stakeholders in various sectors of the construction business in Lebanon to identify the construction flow, the intricacies of activities and milestones, and identifying the stakeholders involved. Furthermore, this section identifies the key steps where decision-making is taken and paves the way to understate the role of stakeholders.

This section builds on secondary data collected using handbooks and manuals to determine the national standards, triangulated with primary data collected by interviews conducted with construction stakeholders.

6.2.1. Construction Flow in Lebanon

The construction process in Lebanon involves many steps distributed over 3 phases: the preconstruction, construction eventually later on decommissioning illustrated in figure 6. The pre-construction phase of the development project relies on defining the scope of work as a collaborative effort conventionally from project managers, architects, civil engineer and clients. Inspired from the scope of work and project requirements and specifications, the architects, chief of engineers along with structural, mechanical and civil, will draw up the construction plans.



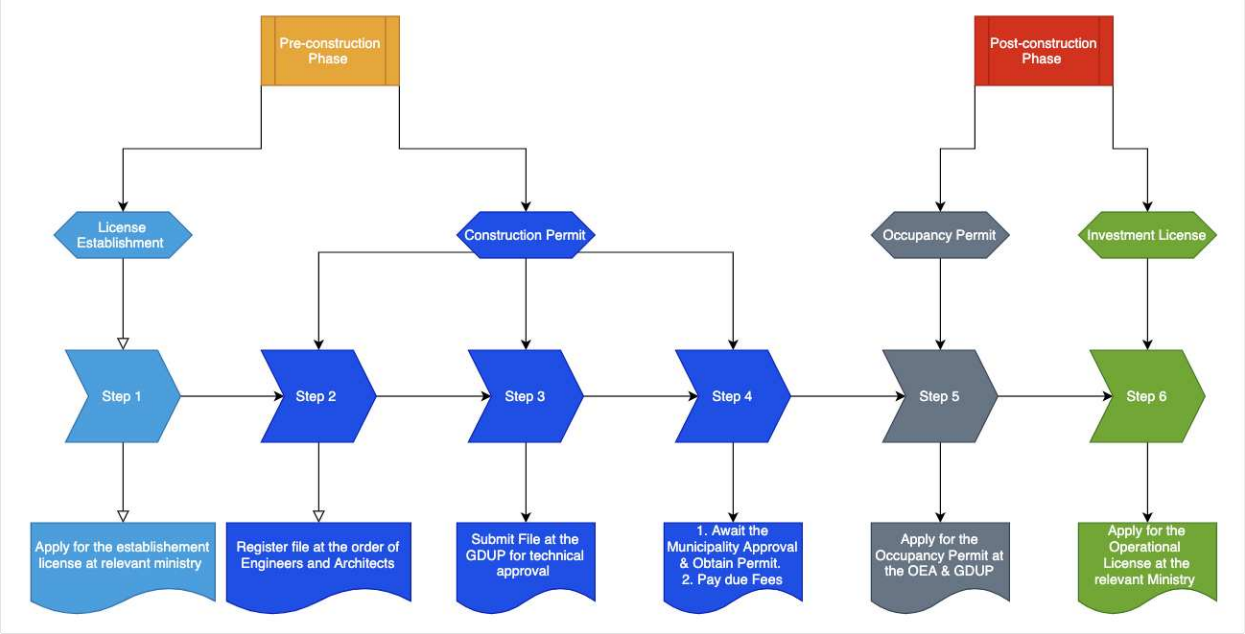


Figure 6:Construction Process in Lebanon using I. Draw Version 5.2

There are milestones in the preconstruction phase none more important than attaining a permit. Permitting is a key step along the construction flow, involving the Order of Engineers and Architects (OEA) (refer to appendix) in addition to the engineering committee of the project, and later the Director General of Urban Planning (DGUP) and/or municipalities. The OEA is the first line of defense for engineers, the guarantor of their rights and their legitimate moral and material interests and it works to resolve disputes that occur between them and their clients. Moreover, enforce disciplinary measures against those who violate the law on practicing the profession, union regulations, and the duties of the profession. It plays a key role in the legislative regulatory affairs related to the profession at the request of the pertinent minister, and in regulating the auxiliary professions in the field of engineering. The syndicate submits proposals regarding technical specifications, standard systems, general and model terms of reference for works, as well as with regard to engineering curricula in engineering colleges and institutes in Lebanon. It organizes educational and training courses for engineers and holds or participates in conferences, seminars, and engineering and scientific lectures, whether inside or outside Lebanon.

The DGUP is under the supervision of the ministry of public works and transportation. The general directorate of urban planning is an administration whose structure is approved by decrees from planning, working, and amending a policy, it has the authority to approve frameworks before referring to the council of ministers.

The Municipalities are responsible for issuing permits and greenlighting civil construction works; it conducts regular visits to sites ensuring conformity with municipal permits and governmental/OEA policy compliance.

After receiving the approved file from the GDUP and other governmental authorities, the process of construction starts. The construction process involves implementing the project scope by mobilizing the resources and acting on the work breakdown structure manufactured by the project scheduling department. In this part, all the formulation ceases and implementation begins. A phase by phase implementation encompassing the activities and milestones is enacted.

The construction phase ends as soon as the final phase of construction is finalized and nothing requiring fiting is required. A file will be deposited to apply for occupancy permit, ratifications, modifications or no action might be required. As a result, the building needing adjustments has to go through them while other not requiring any action will attain the permit. An investment license can be applied for if the designated goal of the construction is for investment purposes, application of an operational license at the relevant ministries is required.

Understanding the construction flow in Lebanon highlights the role of multiple governmental departments and the heavy bureaucratic engagement to reach permit issuing. It also allows us to observe that the pre-construction phase involves the highest number of conceptual decisions undertaken. Leaving few financial burdens on decision making while an exponential increase in monetary cost will be incurred in later stages. Adjustments are best suited for the preconstruction phases as indicated in chapter 1 figures, depicting the cost and influence at each stage. Furthermore, the preconstruction phase holds the stake4holders with the highest stake in the project. It encompasses the most connected stakeholders (frequency of paths).

6.2.2. Pre Construction Phase

Zooming in on the preconstruction phase, resulted in the identification of key activities associated with steering the project to caveat outcomes. Using various information system tools predominantly I. Draw to construct the figure 14.

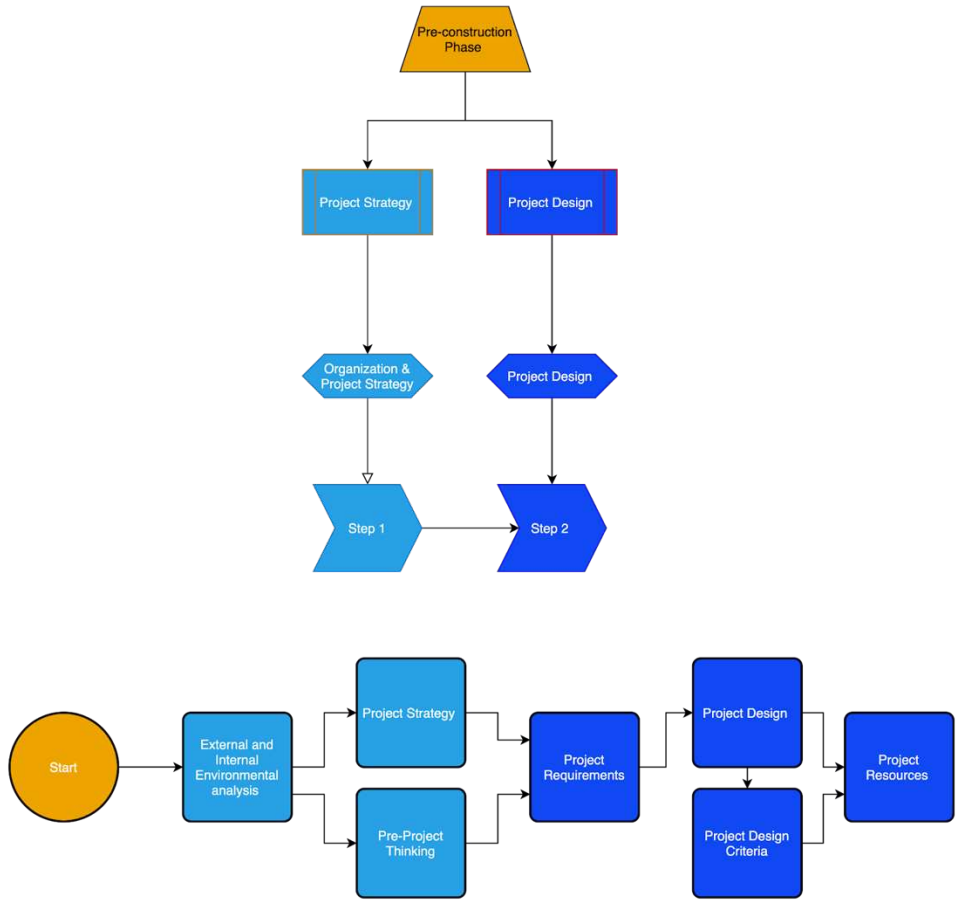


Figure 14: Preconstruction Phase pertaining to Lebanon's construction process

Illustrating the preconstruction flow identifying the various steps towards achieving a construction project in a conventional way. The process starts with organizing and project strategy followed by project design, project requirements, project design criteria, and project resources. These main milestones are handled by stakeholders who have varying interests and expectations.

Each step is color-coded, and identifiable shapes relative to the construction stage are used, facilitating the comprehension of the segmented stages, enabling a visual understanding of the process through clear labels.

The flow of information, decision-making, and step-by-step illustrations for the process of constructing a building in Lebanon, highlight the important milestones and key activities that every project should go through.

Conventional pre construction phase requires traditional use of design, material to be used, and energy efficiency analysis, the conventional building does not have any environmental goals and most are designed with ample energy efficiency analysis. Conventional pre-construction has activities and milestones tailored to each environment and location.

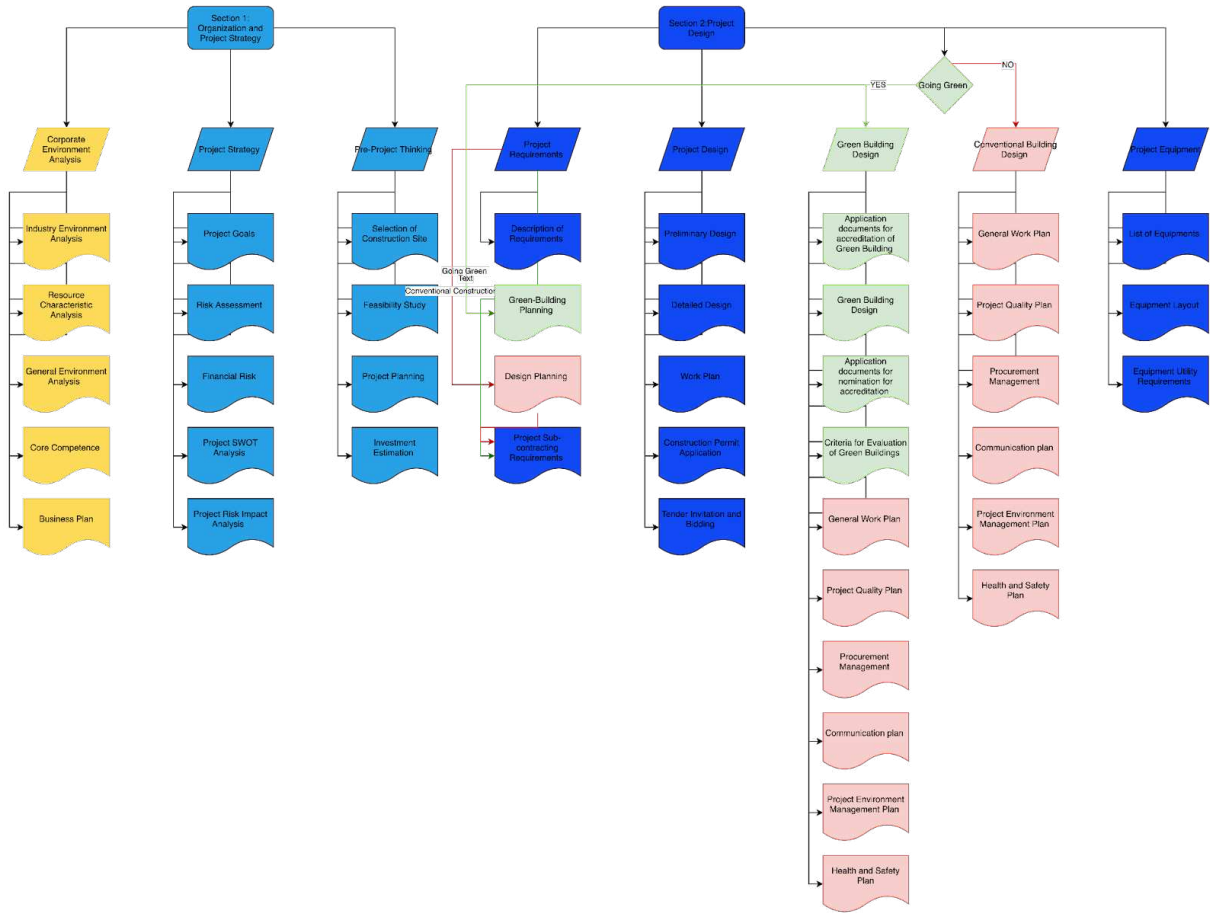


Figure 15: Pre-construction activities and Decisions Deconstruction

Figure 15 exhibits the complex activities required to be implemented to achieve set milestones and analyze the importance of each task relative to another through illustrating the critical path and understanding the resources and stakeholders role,impact and importance. Interviews conducted with LEED and BREEAM assessors along with numerous stakeholders narrowed down pivotal points in construction whereby the cost of shifting from conventional to green is determined to be crucial. However GRS assessors indicated that project design step in the pre-construction is pivotal as the decision from that point on is financially overarching, construction project needs to

be designed to fulfill GRS requirements and later adjustments will cost a fortune and most deem it too expensive to go forth with.

Figure 15 furthermore illustrates the paths the construction project can take, highlighting the latest switch point, where according to an interview with Saab (Saab,2017,per comm,appendix)

The figure 15 shows the variety and novelty of the various paths the green building should undergo in order to attain a green building it shows the variability in the design phase. Moreover, exhibits the entry points pertinent to the criteria prescribed in a particular GRS and where they can be involved.

It shows 2 paths that can be taken reaching 2 different goals, one conventional the other green, splitting at the project design phase. The preconstruction phase is designed using the information acquired from interviews by many stakeholders primarily GRS assessors, Green rating system enactors and secondary data available compiled from manuscripts, handbooks and guides.

As it. The content of the activities is pertinent to achieve specific steps stipulated in guidebooks. To liaise between the guidebooks and construct a work breakdown structure interviews conducted with Khoury (Khoury,2018,per comm, appendix) highlighted the relationships and continuum towards attaining construction milestones. Green inferences in the pre construction start with step 1 program planning and site selection and ends with step 5 building system design.

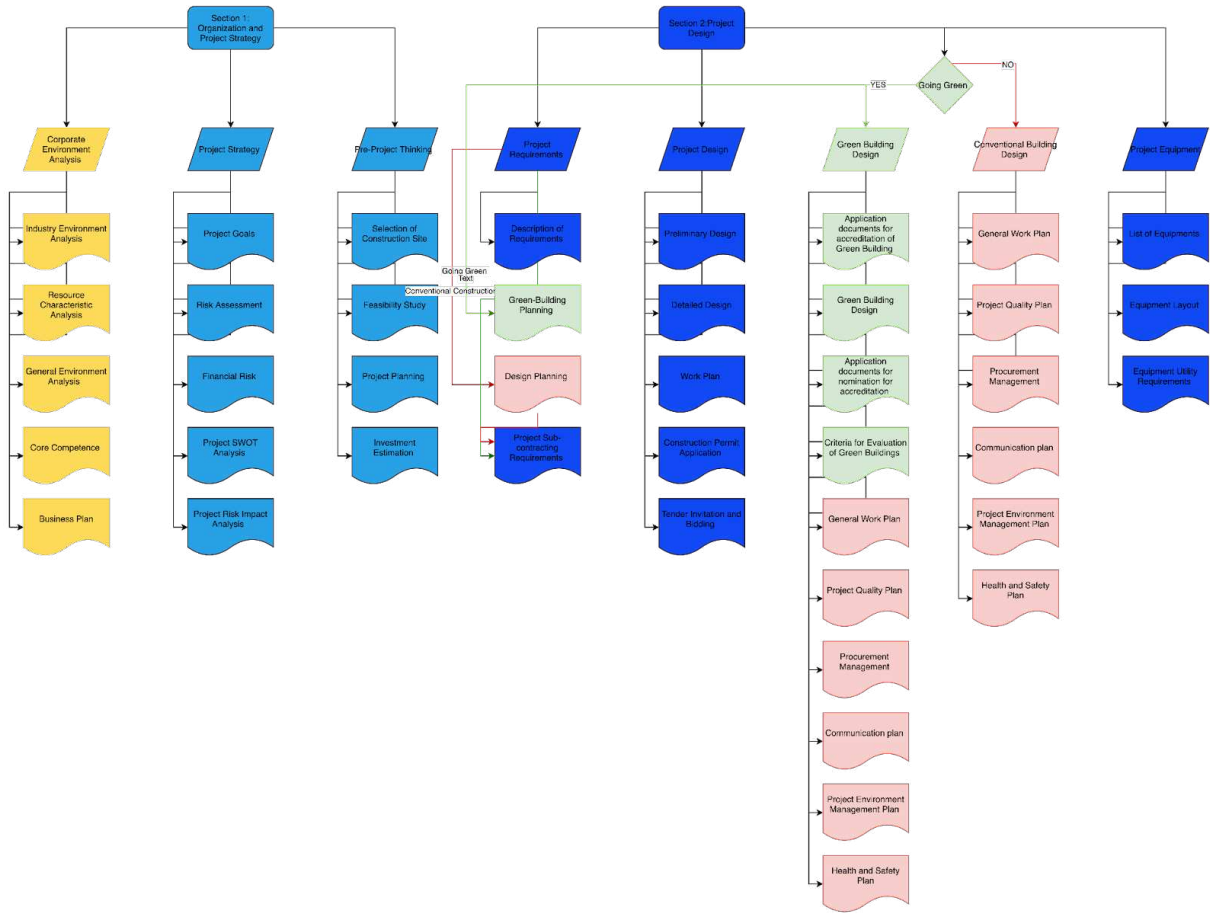


Figure 16: Work Breakdown Structure of Section 1 and 2 in the preconstruction phase illustrating the conventional and green approach.

figure 16 illustrates a compilation of information obtained from interviews, focus groups and secondary information documents to highlight the different steps and pathways a green construction developer needs to take into consideration to follow through a green construction. it shows the multitude of different sequencing and added tasks stakeholders should perform in order to achieve a green certification. However, this design is pertinent to the Lebanese context taking into consideration the various national and international construction processes depicted in FIDIC.

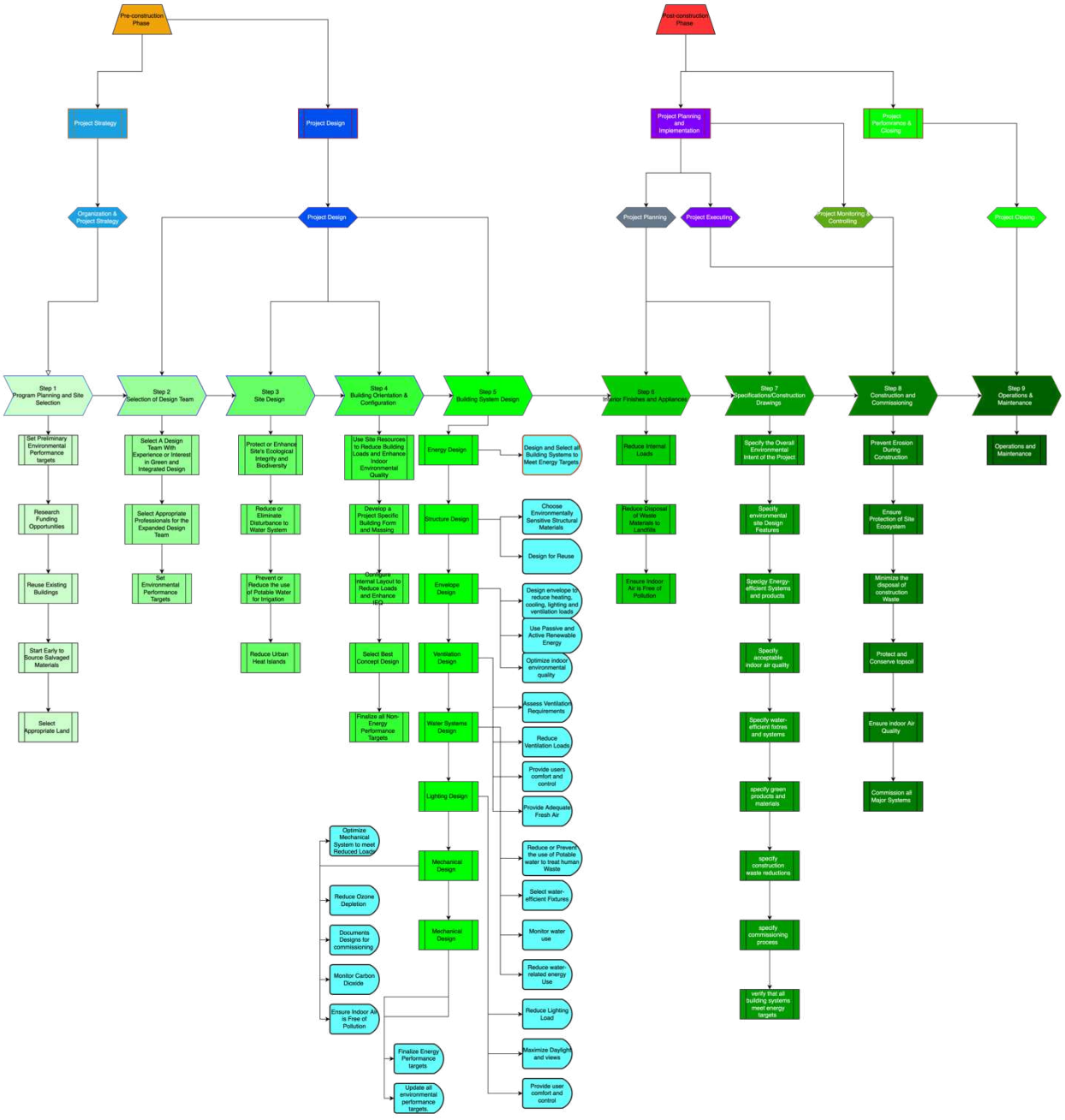


Figure 17: Green Building Project Construction Phases

Steps 1 through 5 constitute the pre construction phase of the green building project. Key milestones such as what green rating system and level to be adapted and aimed for, the financial commitment and level of milestone is of critical importance as the conceptual decision makers identify the usefulness, viability and expectations from the project. As the process of pre construction proceeds the project strategy theme incorporates the project goals risk assessment financial risk SWOT and risk impact assessments. These key activities can shift decisions

pertaining to project scope. Pre project thinking follows project strategy in it are critical milestones such as selection of site and feasibility study project planning and investment estimation. The aforementioned steps contain the highest level of decision making in the project as the client expectations are being realized in a feasible profitable project. Section 2 project design presented in figure 17 illustrates the various activities that are undertaken in the construction project.

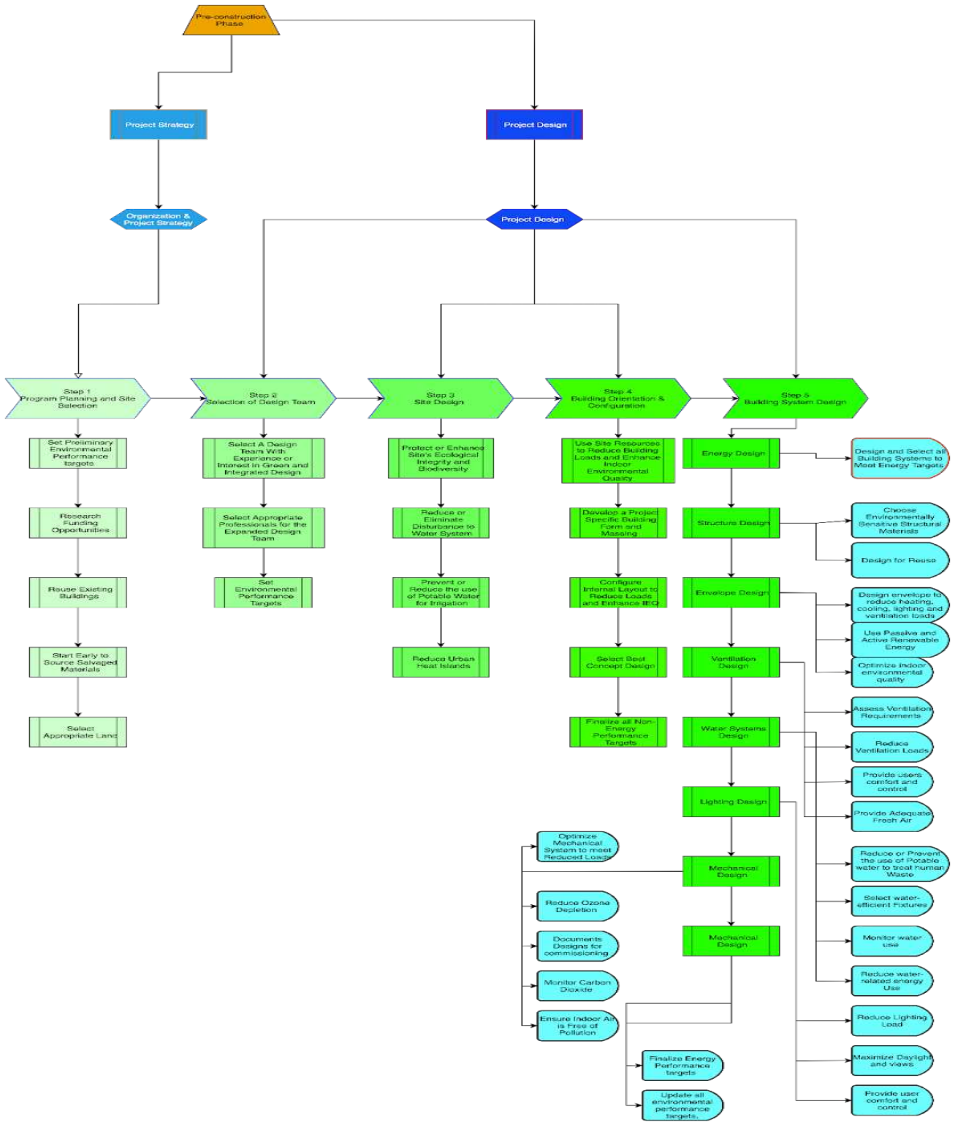


Figure 18: Green Construction Work Breakdown Structure Zooming on the preconstruction Phase

The Complex construction flow process in Lebanon (Figure 18) encompasses many steps starting from pre-construction (design phase) to delivery. The Stakeholders' role play in the construction

stages is a dynamic process where the impact of actors can be exasperated or minimized. Furthermore, along with the construction flow many external influential factors can intervene at different incidents affecting the flow of work, such as socio-political instabilities, financial incentives, corruption and bribery, government policies and regulations as well as the green building context encouraged by international movements. In illustrating the conventional design approach, an analysis was made to evaluate the power and impact of each stakeholder enabling us to assign values to tasks which their potential impact on the overall construction project is critical.Design and initiation phase in construction presents the greatest opportunity for influential conceptual stakeholder to steer the project to their preference as nothing has been materialized.
Understanding the intricate network and communication matrix between stakeholders at different levels enables us to understand the dynamics of design and the input output process occurring at each activity, furthermore ,enabling the understanding milestones, barriers and in-between leading us to develop a tailored green design phase depicting our analysis of project stakeholders and decision outcomes.

6.3. Defining the Role of Stakeholders along the Construction Process Towards Green Building

6.3.1. Stakeholder Management using Social Network Analysis.

The relations among the stakeholders and the way which they are structured into an overall network pattern can be examined by a social network analysis through looking beyond the individual actors' attributes and discovering how they are positioned within the network. Prioritization of stakeholders' impacts on the outcomes of a particular organization or activity, based on their certain attributes like knowledge, interest, power, urgency, legitimacy, etc. provides a traditional approach to stakeholder analysis
Stakeholders were first identified using secondary sources such as journal articles and construction handbooks such as FIDIC. Moreover, through interviews, stakeholders were classified as per their power and unique relationship span in Lebanese construction projects.
In this research, many respondents participated. They were identified through the researcher, and co-thesis director's contacts and then using snowball sampling. Their expertise and multirole are in managing and impacting construction projects in Lebanon

As shown (Table 3, Appendix) by the respondents' profiles, participants were selected based on their job position, type, and background. Most participants were project managers or construction general managers, assessors meaning they knew about managing conventional and green construction projects. Additionally, they had experience in the construction industry and building projects specifically, making them able to identify the stakeholders that should be involved in defining the project and elicit their importance to each element in the project initiation. Moreover, most of the respondents had both technical, social, and management experience. The respondents' profile evinces that the sample was appropriate for this research.

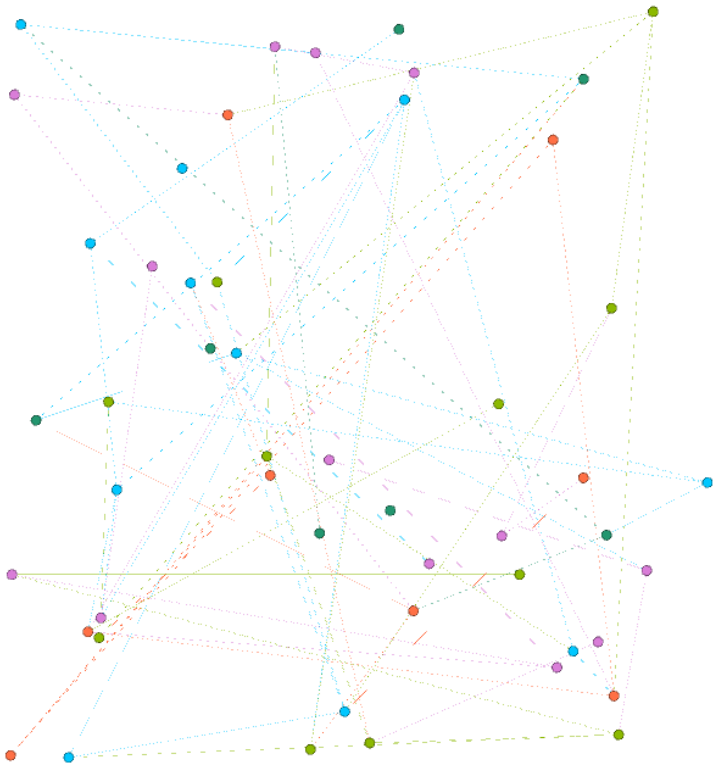
The respondents' profile shows participants included representatives from a variety of stakeholder categories. Their level of experience enables them to recognize and express their interests and concerns regarding construction projects. A total of 21 stakeholders, representing each stakeholder category and identified through their involvement in the green projects, were invited to participate in the study.

The variety of stakeholder categories represented is noticeable, taking into consideration that the project team includes the project manager, architect, structural and various types of engineers, planners and schedulers, banks, Government representatives, Bank Employees, and NGOs. The respondents were capable of identifying key stages and activities for relevant project elements and green inference for green construction projects.

The design and initiation phase in construction presents the greatest opportunity for influential conceptual stakeholders to steer the project to their preference as nothing has materialized. In illustrating the conventional design approach, an analysis was made to evaluate the power and impact of each stakeholder enabling us to assign values to tasks whose potential impact on the overall construction project is critical.

To develop the network of the research, the identified key stakeholders' relationship were extracted as the network nodes using their representatives' connections.

At this stage, hundreds of dependent and independent relationships were identified pertaining to conventional and green construction. Each stakeholder's path in the different phases of the project are exhibited in graphs below.



At the next stage, the links were shown by defining the extents of a stakeholder's relationships pertaining to the construction phases in both modules.

Starting with conventional approach depicted in figure 19:

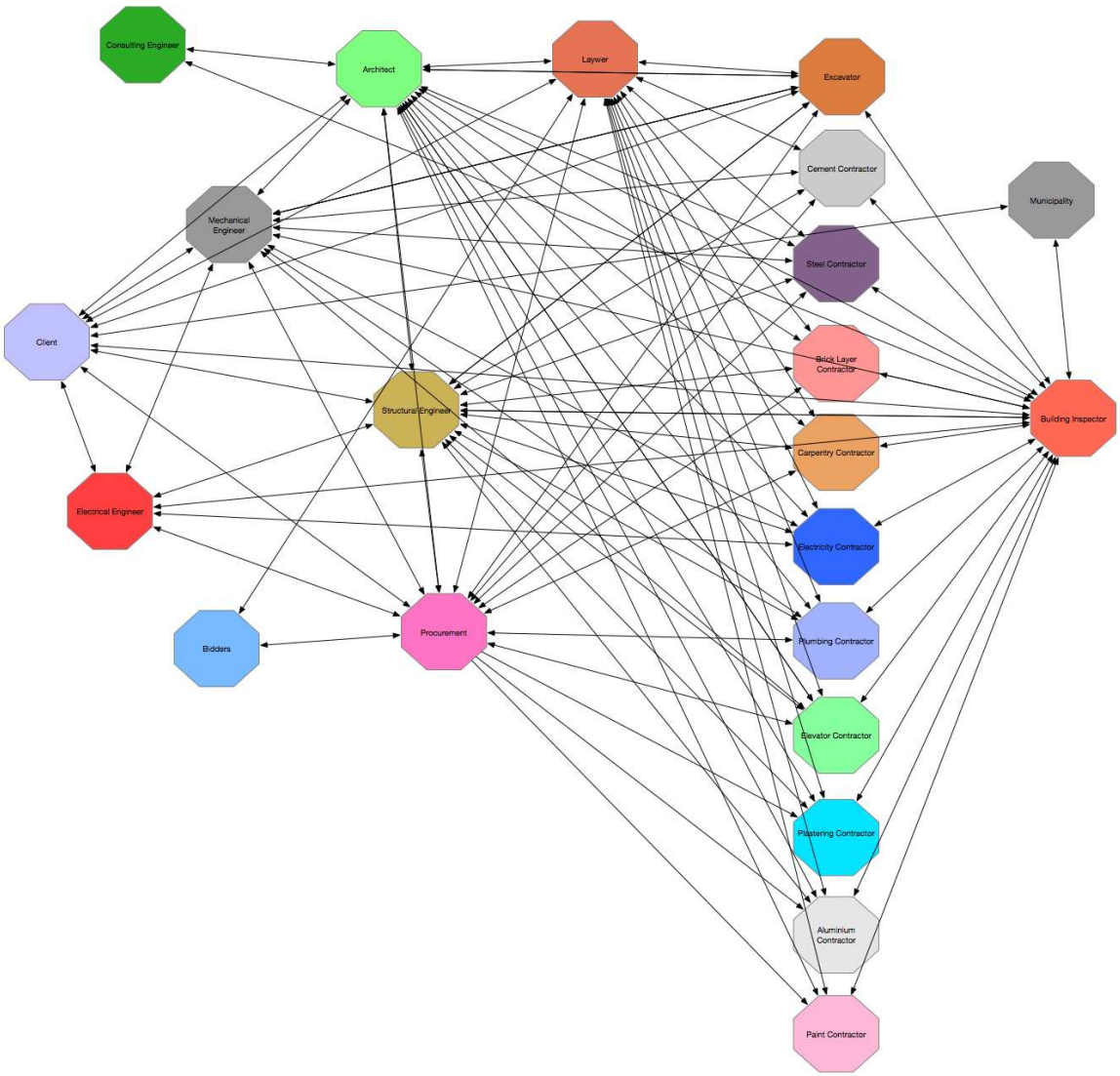


Figure 19: Network Pertaining to construction process in Lebanon using OmniGraffle

Illustrating the nodes and paths in the conventional construction in Lebanon. Highlighting the role of building inspectors granting permissions to every step along the way and role of architect in mitigating and laizing between different stakeholders.

Due to the limited information in the other phases, only the information outputs are displayed. The project network density in the different phases ranged between 0.2 and 0.5. The mean distances between the nodes and the network cohesion showed the ranges of 1.5–2 and 0.9–1, indicating a dense network with a complex structure across the phases. Each arrow represents the presence of an impact relationship between a pair of concerns relevant to each stakeholder, while the thickness of the arrow indicates the impact level.

Accordingly, the more central the position occupied by the stakeholder the more connections in the network , the fewer links , closer links to the outrebound of the network.

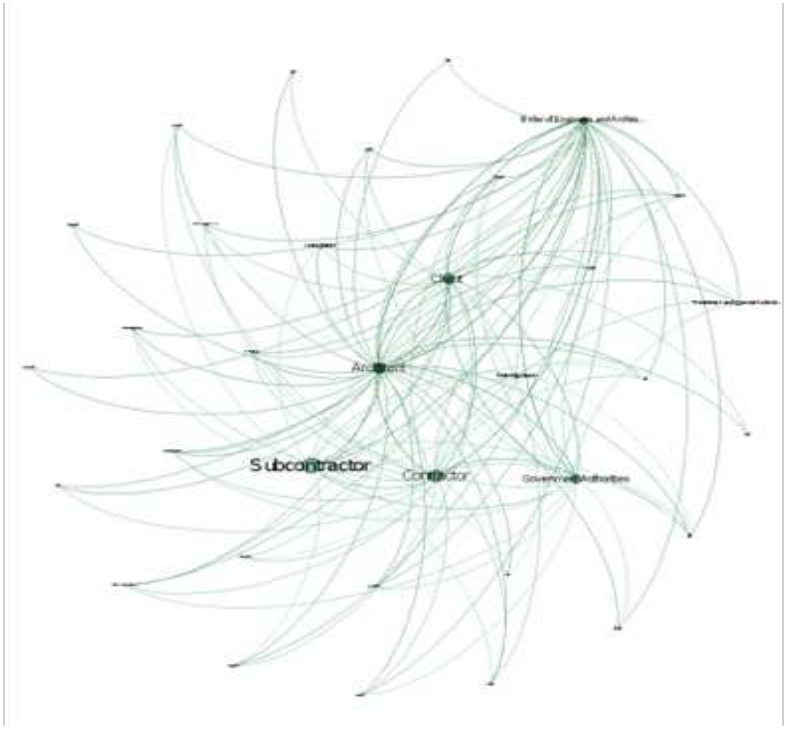


Figure 20: Green Construction path network in Lebanon Using Gephi Version 0.9.2

Primary insights into the overall structure of the network have been provided via its visual map and inspection. The presence of an internal relationship between the network nodes indicated the network complexity.

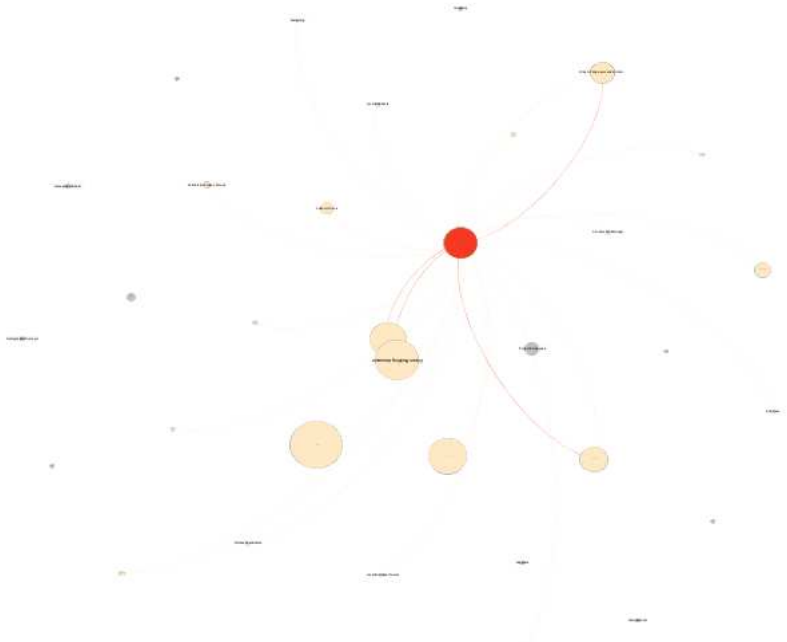


Figure 21: Heat Map of stakeholders involved in the construction process highlighting the critical paths using Gephi 0.9.2

As shown in Figure 21 ,indicating the heat map of the construction process, highlighting the role of the architect as most pivotal as well as the role of the client, OEA, and construction developer. The internal stakeholders in the network and the external stakeholders have important roles in driving the construction process. In addition, the diversity of the stakeholders with their different concerns in the network center reflects the network complexity and diversity.

The main objective and focus of this research was to identify the relationships between the stakeholders at different construction phases and modules, besides taking into account the stakeholders' changes and their relationships at different times in the project. To analyze the network results, various indicators such as authority and hub were used to identify the stakeholders with most impact and to track the potential impact of those stakeholders in shifting construction from a conventional approach to a green one.

6.3.2. To What Extent an Inferential Stakeholder can Influence Gearing Green Construction in Lebanon.

Interviews with construction developers identified players with various interests along various construction processes, such as the Order of Engineers and Architects having high power and impact along the preconstruction process and the post-construction as they hold the right to grant a construction permit and the domiciliation permit. While clients have the overarching decision on the formulation, implementation, and evaluation of the project. Architects in Lebanon are instrumentalists, navigating various stakeholders along the construction venture.

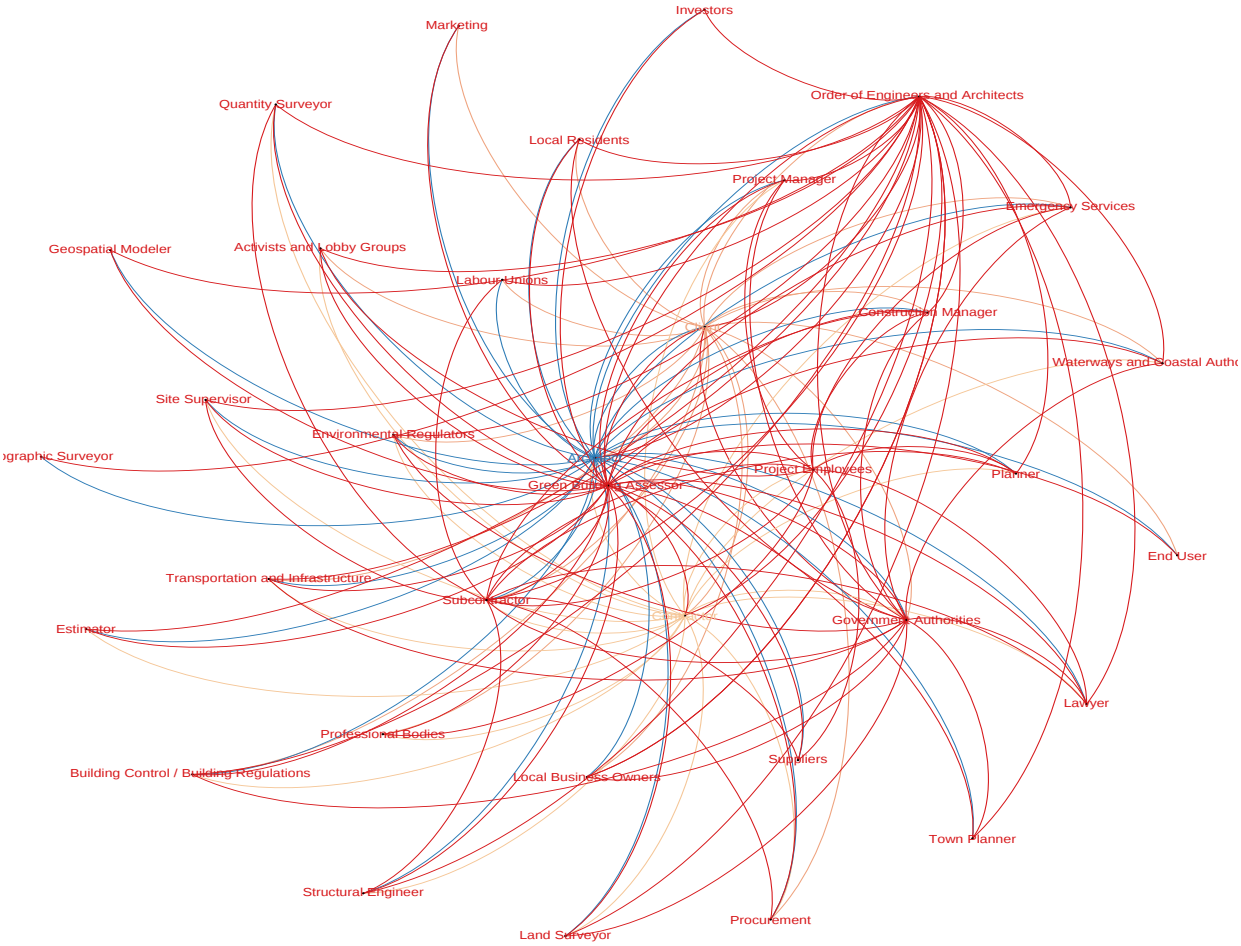


Figure 23: Construction social network in Lebanon using Gephi version 0.9.2

Relationship frequency was used to create relationship and decision-making views of the pre-construction phase. Network nodes were connected based on the type and frequency of the

relationship, formal structure, decision team, and solo structure. Another goal was to calculate the geodetic distances between all nodes in the network to reveal isolated, network decision teams and the ability of a single individual or entity to interact with others in the network.

Two network representations were designed to illustrate the change of its formation and metrics when construction is conventional and the other when adopting a Green construction project. Measurements of the two networks are shown in Table. Their density was calculated along with their average degree, diameter, average path length, and the centralities of each participant. The intricacy of the network in construction has led the researcher to delve deeper into the relationships that exist and the power associated with them. Both networks illustrate the complexity of a construction project however it also shows the power few stakeholders have in the preconstruction phase as most of the directional relationship exists between inferential stakeholders. Highlight the relationship and the intricate number of paths pertinent to the existing network relationship.

The communication and relationship network was graphed by calculating the authority and hub using Gephi, we deduced that the stakeholders with the highest authority are the client contractor, architect, order of engineers and architects, and Green Building assessor.

Table 5: Authority and Hub Values Derived from Gephi version 0.9.2

Id	Label	Authority	Hub
0	Client	0.304407	0.304405
1	Contractor	0.286007	0.286001
2	Architect	0.35075	0.350737
3	Subcontractor	0.233404	0.233406
4	Project Employees	0.150079	0.150075
5	Suppliers	0.078228	0.078232
6	Government Authorities	0.270908	0.270905
7	Local Residents	0.115814	0.11582
8	Activists and Lobby Groups	0.102242	0.102246
9	Labour Unions	0.088545	0.088548
10	Professional Bodies	0.078687	0.07869
11	Local Business Owners	0.114842	0.114848
12	End User	0.072444	0.072448

Id	Label	Authority	Hub
13	Project Manager	0.147709	0.147716
14	Site Supervisor	0.111725	0.111731
15	Structural Engineer	0.111725	0.111731
16	Geospatial Modeler	0.073735	0.073739
17	Quantity Surveyor	0.111725	0.111731
18	Hydrographic Surveyor	0.049208	0.049211
19	Construction Manager	0.143863	0.143868
20	Planner	0.122702	0.122708
21	Town Planner	0.093549	0.093554
22	Lawyer	0.142516	0.142523
23	Investors	0.073735	0.073739
24	Emergency Services	0.147709	0.147716
25	Marketing	0.072444	0.072448
26	Procurement	0.110435	0.110439
27	Estimator	0.094653	0.094659
28	Land Surveyor	0.114468	0.114474
29	Environmental Regulators	0.136732	0.136739
30	Order of Engineers and Architects	0.322064	0.322051
31	Building Control / Building Regulations	0.136732	0.136739
32	Transportation and Infrastructure	0.136732	0.136739
33	Waterways and Coastal Authorities	0.136732	0.136739
34	Green Building Assessor	0.335346	0.335334

By identifying and analyzing the project stakeholders and inferring their potential impact and decisional swings, this research highlights a particular stakeholder. Focusing on the ability of this stakeholder to impact the decision towards adopting green construction on conventional ones. One of the major stakeholders that have leverage and authority over major stakeholders is the OEA.

Discussion and Conclusion

This thesis falls in the overall context of answering the pressing needs raised by local and global environmental concerns and the overarching global commitment of countries to the United Nations 17 Sustainable Development Goals, in particular, in the charter of SDG 11 on Sustainable cities and communities in the Mediterranean environments.

To understand the challenges hindering Lebanon from shifting to sustainable construction this work focused on 1) addressing the Smart city concept as a viable solution to lead to construction sustainability in Lebanon, 2) exploring the possibility to rely on Green Buildings as a viable pathway toward sustainable construction in Lebanon and finally 3) an understanding on what aspects can inferential stakeholders influence the adoption of sustainable construction in Lebanon.

How far are we from Smart Cities as a lead to sustainability in construction in Lebanon?

In chapter 5, the findings were deduced from mapping and classifying the stakeholders pertinent in formulating a smart city vision and analyzing their roles and relationships. The results indicate the lack of governmental vision able to lead, minute awareness among the stakeholders able to gear such an eventual shift towards Smart Cities in Lebanon, and essentially limited/absence of resources dedicated for such a shift. The results were communicated with the International community through 1 oral communication (LAAS, Fenianos et al., 2018) and 1 published peer-reviewed paper (MTO , Fenianos et al, 2020).
Laas oral communication explored the state of art of Lebanon within the context of green buildings. Highlighting the types and numbers of green building pending and certified. Showing that the most adopted GRS where the international ones while timid national undertaking of the Lebanese GRS ARZ. Furthermore, addressed various limitations of several GRS comparing their criteria, scoring and certification levels. MTO addressed the readiness of Lebanon to shift towards smart cities, results show that due to the pivotal role the government has as a facilitator and investor in that endeavor is virtually not present rendering the shift challenging. The role of stakeholders, especially government, where identified and evaluated based on interviews and secondary data compilation. Aiding in formulating a network analysis using software's to analysis the power, impact and relationships that exist between stakeholders.

Various limitations were faced both in the oral and peer reviewed article, as the data was based on interviews, as the result being bounded by the information and subjective opinion of the interviewee. Lack of resources to address the problematic, such as using quantitative methods to enable triangulation and explore various avenues of the research, limited its scope.

Are Green Buildings a viable alternative to sustainable construction in Lebanon?

As the concept of a Smart City is farfetched as a choice toward sustainability for Lebanon, chapter 6 attempted to understand the challenges hindering the shifting to sustainable construction building on a multiproxy approach mixing Geographical Information Systems, Social Network Analysis, purposely sampled interviews of Semi-structured and unstructured types.

The thesis explored the possibility to rely on Green Buildings as a viable pathway towards sustainable construction in Lebanon, and has consequently confirmed that International Green Rating Systems (LEED, BREEAM) not only exist in Lebanon but are implemented and recommended; Lebanon has developed a National GRS (ARZ) that is adapted to existing commercial buildings but is not available for residential or new buildings. The GIS analysis has confirmed that existing green buildings are still timid and scattered across the Lebanese territory. This timid adoption of GRS in Lebanon is probably due to a lack of awareness of GRS as an alternative to conventional construction projects; High initial investment requirement posing a challenge for small and medium developers; complex bureaucratic processes, as the government is still in a brick-and-mortar phase. This resulted in a noticeable cost-benefit deficit where the cost of upscaling a building to green can not materialize financially. The findings were communicated in (LAAS, Fenianos et al., 2018). Comparing Lebanon to other nations on a scale of demand for green buildings is fair as neighboring countries face somewhat similar attraction rate. lack of demand of green buildings is shared due to many reasons, one of which the lack of awareness, as there are few financial schemes aiding the transition and cutting on bearing the extra burden of initial investment the developer has to incur. Moreover, few stakeholders interviewed had recognized what a green building is. Thus an rendering an inferential stakeholder ineffective to a construction project to shift towards green building. Stakeholders should be made aware of green alternatives to conventional approaches in construction. Aiding

thew shift using existing financial and non-financial incentives. Lebanon compared to international countries lack a comprehensive GRS, ARZ is limited to commercial existing buildings while multitude of international rating systems encompass full scale situational construction. ARZ can be revolutionized, marketed and enforced leading to better results as other countries have don such as UAE with Estidama. Using the Government and non-governmental authorities to enforce new standards and legislatives. Stakeholders are instrumental in influencing through their relationship and responsibilities the adoption of sustainable approaches.

What role can the Order of Engineers and Architects- as an inferential stakeholder, play in gearing sustainable construction in Lebanon?

The research explored aspects on which inferential stakeholders could influence the adoption of sustainable construction in Lebanon. The analysis of the construction process confirmed the pivotal importance of the pre-construction phase in gearing construction toward green and sustainable constructions. The Social network analysis showed the direct and indirect networks existing in conventional and green construction, confirming that the go and forth between administrative/ technical processes leading to Green construction is complex. The cross-functional activities prevalent in green construction require conscientious project management as inferential stakeholders' expectations are intertwined and strongly interconnected.

In order to enact change, we recommend scaling the adoption of GRS not only to primary stakeholders but to secondary ones as well. Change can be set through voluntary or involuntary means. Starting with voluntary, creating a need for Green buildings in Lebanon should pass through various hierarchical avenues for change to be realized. Starting with financial and taxation incentives tracking the upper echelon, by backing entrepreneurial ventures driving towards wider adoption by levying the financial risk. Second, buyers should be made aware of the potential advantages of owning a green building as the premium initial cost of purchase will be offset by the high efficiency and effectiveness of resources utilized. Involuntary can be through enacting SC through government legislation.

Due to the high frequency of directive nodes and its multifaceted portfolio of receivers, the Order of Engineers and Architects plays an essential role as an inferential stakeholder in gearing toward sustainable construction, encompassing them in awareness-raising programs and educational support to universities and fresh graduates. The OEA can play a fundamental role in advocating for new governmental regulations and imposing higher environmental standards for syndicate members. On another note, the OEA can incentivize its affiliates to shift from conventional construction to sustainable one via increased quota and reduced permit costs for example. The role of the OEA is indispensable and the findings stress endorsing a new role as a sustainability change agent.

It can aid in shifinting the construction industry culture in Lebanon from traditionally being focus on speed and cost, rather than sustainability. Enabling a significant shift in the mindset and invement education and training which the oEA ca develop. Based on the research, OEA can develop educational materials that address the motivations and barriers of the key government authorities. These materials can be tailored to the specific needs of each group, highlighting the benefits of green construction practices and addressing any concerns or misconceptions. Engage in targeted outreach can then engage in targeted outreach to the key government authorities, using the educational materials to build relationships and increase awareness of the benefits of green construction practices. This outreach may include meetings, workshops, and other events. Furthermore tackling the lack of public awareness in Lebanon thus generating demand for green buildings and build political support for green building initiatives. At a later stage the OEA shoud monitor evaluate the effectiveness of their outreach efforts over time. This can be done by tracking changes in the attitudes and behaviors of the key government authorities, as well as the adoption of green construction practices more broadly.

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Appendix

Publication 1:

Green Buildings and their contribution to establishment of Smart Cities – An approach from complex Mediterranean Cities - Lebanon.

Fenianos, O.; Khater, C.; Gerbaix, S*; Fenianos, J.; Faour, G.

Résumé

"Smart cities" durables se développent avec une approche globale de la cité. Ce concept se traduit par des réalisations de par le monde et pas seulement dans les nations écologiquement et technologiquement avancés.Dans cette quête vers la "durabilité", certaines villes adoptent une

approche de type “Smart Cities” alors que d’autres parviennent à atteindre un certain niveau au cours du processus de construction au travers d’initiatives et éparses et dispersées qu’il s’agisse de construction certifié “verte” ou éco-durable ou de quartiers respectueux de l’environnement. Les constructions certifiées “vertes” (Green rating buildings) sont des constructions qui respectent des normes régionales, nationales ou internationales et au travers leur conception, leur construction ou leur fonctionnement sont susceptibles de réduire ou atténuer les effets négatifs sur l’environnement. L’intelligence de la ville est créés par l’interconnexion des réseaux qu’il s’agisse de télécommunications, de réseaux numériques, d’intelligence intégrée dans les capteurs et composants physiques ou logiciels des systèmes.
Situé sur la côte orientale du bassin méditerranéen, le Liban est un petit pays, de 10,452 km2, essentiellement montagneux, qui compte 6 millions d’habitants. Au cours des décennies passées, le Liban a été le témoin d’une urbanisation extensive non planifiée et non réglementée aboutissant à une pression accrue sur les ressources et les écosystèmes naturels. Nous nous demandons dans quelle mesure les Normes vertes (Green Rating Systems GRS) peuvent contribuer à la création d’un noyau, vers des villes intelligentes dans une ville dont le système socio-politique est particulièrement complexe tel que Beyrouth et sa banlieue immédiate. Cet article vise à estimer les changements potentiels vers la réalisation de Smart Cities”, changements induits par l’existence des Constructions Ecologiquement Certifiées, des initiatives environnementales et de l’évaluation des potentialités résultant de la mise en oeuvre des Systèmes d’information des constructions vertes.
Nous avons développé une matrice de comparaison des critères internationaux (LEED ; BREEAM) et des systèmes d’évaluation verts (ARZ) nationaux et nous avons aussi construit un Système d’information géographique pour permettre la collecte, l’analyse et le stockage des données. Les informations sur le nombre total de construction par quartier, le nombre et la localisation des Constructions certifiées “vertes”, et la distance ente elles sont enregistrées dans la base de données du système d’informations géographiques.
Nos résultats montrent que des constructions certifiées vertes avec les standards LEED, BREEAM ou ARZ, même si leur contribution demeure encore très timide, représentent une étape importante vers les des villes intelligentes,

Abstract

Smart sustainable cities are rapidly gaining momentum as a holistic urban development approach. Thereby the concept is evolving into a realist enterprise across the world, not least within ecologically and technologically advanced nations. In this overall quest towards sustainability, cities are either adopting the “Smart City approach” or result in reaching a certain level along the process through private and scattered initiatives ranging from green buildings to environmentally friendly neighborhood. Green Rated buildings are constructions that comply with international, regional, or national standards and that in their design, construction, or

operation, can reduce or mitigate negative impacts, on the natural environment. The intelligence of the city is created by interconnecting digital telecommunication networks, the intelligence integrated into systems sensors, and physical components as well as software tools. Located on the eastern coast of the Mediterranean basin, Lebanon is a small, mostly mountainous country, of 10,452 km2 with a population of approximately 6 million inhabitants. Over the past decades, Lebanon has witnessed unplanned and unregulated urban sprawl resulting in an increased pressure on natural ecosystems and resources. We wonder to what extent the Green Rating Systems (GRS) can contribute to the creation of a nucleus towards Smart Cities in a complex socio-political city such as Beirut and its direct suburbs. This paper attempts to evaluate the possibility of shifting to Smart Cities or smart neighbourhood based on the existence of certified Green Rated Buildings, environmental initiatives and assessing the potentials of the implementation of Information systems to green building towards Smart Cities.

We have developed a matrix comparing the criteria of International (LEED; BREEAM) and national (ARZ) Green Rating Systems and have also built a Geographic Information System (GIS) to enable data collection, data analysis and data storage. Information on the total number of buildings per neighbourhood, number, and location of Green Rated Buildings (GRB), the distance between GRB are recorded into the GIS database. Our results show that Green Buildings, certified under either LEED, BREEAM or ARZ rating systems represent an important step to establishing Smart Cities, however, their contribution to the overall pathway towards them remain very shy.

Keywords
Network actor theory, Stakeholder Management, Sustainable Development, Information and Communication Technologies (ICT), Green Rating Systems, Geographic Information System(GIS), Stakeholder Mapping.

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Green Buildings and their contribution to establishment of smart cities – An approach from complex Mediterranean Cities - Lebanon.

1. Introduction

The Smart City (SC) refers to that place and territorial context, where use of planned and wise of the human and natural resources, properly managed and integrated through the various ICT technologies already available, allows for the creation of an ecosystem that can be used of resources and to provide integrated and more intelligent systems (Lazaroiu et al., 2012).

The SC through ICT appropriately integrated with a network of fixed and mobile telecommunications can guarantee a real improvement in the quality of life, job creation and urbanization understood as the sum of the environmental and social sustainability, development, and cost savings.

Smart sustainable cities are rapidly gaining momentum as a holistic urban development approach. Thereby the concept is evolving into a realist enterprise across the world, not least within ecologically and technologically advanced nations. In this overall quest towards sustainability, cities are either adopting the “Smart City Approach” or result in reaching a certain

level along the process through private and scattered initiatives ranging from green buildings to environmentally friendly neighbourhood (Bibri, 2018).

When discussing Smart City, you must think about a developed urban area that creates sustainable economic development and high quality of life by excelling in multiple key areas, economy, mobility, environment, people, living and government (Karnouskos and De Holanda, 2009; Lazaroiu and Roscia, 2012; Albouy et al., 2013). Excelling in these key areas can be done so through the strong human capital, social capital and/or Information and Communication (ICT) infrastructure (Moslehi, 2010).

Green Rated buildings are constructions that comply with international, regional, or national standards and that in their design, construction, or operation, reduces or mitigates negative impacts, on the climate and natural environment (Worldgbc.org, 2018).

While Smart Cities as defined by Giffinger 2007, are those cities qualifying simultaneously to indicators on Governance, Economy, Mobility, Environment, People, Living (figure 1). Information technology and communications is essential in the mart city allowing it to efficiently use the infrastructures and promoting strong integration of all dimensions of the Smart City, which refers to the human intelligence, the collective intelligence as well as to artificial intelligence of the physical components of the city (Albino, Berardi and Dangelico, 2015)

The intelligence of the city is created by interconnecting digital telecommunication networks, the intelligence integrated into systems sensors, and physical components as well as software tools.

Located on the eastern coast of the Mediterranean basin, Lebanon is a small, mostly mountainous country, of 10,452 km2 with a population of approximately 6 million inhabitants. Over the past decades, and due to regional socio-political instabilities, Lebanon has witnessed unplanned and unregulated urban sprawl resulting in an increased pressure on natural ecosystems and resources (Verdeil & Faour 2010).
We wonder to what extent the Green Rating Systems (GRS) can contribute to the creation of a nucleus towards Smart Cities in a complex socio-political context.

This paper attempts to evaluate the possibility of shifting to Smart Cities or smart neighbourhood based on existing Green Rated Buildings and other environmental initiatives towards Smart Cities.
It presents briefly the context of the study, Lebanon as a typical case for Mediterranean countries, the theoretical background linked to actor-network theory, then the methodological approach used and the main findings of the paper before ending by a general conclusion.

II- Context of the study: Lebanon

Unlike many developed countries, Lebanon has no centralized governmental approach implemented to respond to the challenges of such an urban growth. Nevertheless, on December 2007, the Lebanese Central Bank (BDL) signed an agreement with the European Union targeting the support of SMEs' Energy Saving Investments and encouraging Certified Green Buildings by giving these projects special conditions in the Energy Loan valuation (Banqueduliban.gov.lb, 2018).

Prior to the series of socio-political instabilities, the property sector had always been important, with a substantial portion of the activity concentrated in Beirut, where the housing needs of the city are rapidly increasing urban population had to be met.

The real estate market in Lebanon is one of the economic pillars where the sector contributes to nearly 15% of GDP (from nearly USD 8 billion in 2015 to USD 8.4 billion in 2016, an annual increase of 4.9%annual increase of 4.9%).

Adding to the 6 million living in Lebanon there exist another 14 million expats living abroad, where few of them are investing in their motherland through the real estate's adding onto the already existing problem of urban sprawl

III. Theoretical Approach : Actor Network Theory.

Based on frameworks developed by numerous authors, this paper builds on the use of the actor's network theory (ANT) in order to explain the interrelationship between the various Smart City Stakeholders.
In the information system literature, graphical representations often accompany Actor-Network Theory analysis of Information system initiatives, serving as tools for improving the visibility of the case and interest and power of actors (Bengtsson & Lundstrom,2013).

Using Fournier and Grey's (2000) framework as a root for their studies Whittle and Spicer,2008, argue that ANT can provide researchers with a realist account of the stabilization of networks of

human and non-human actors, based on a positive theory of knowledge, and explain how power relations are constructed."

According to ANT, are understood as networks of heterogeneous actors—social, technical, textual, naturally occurring etc.—brought together into more or less stable associations or alliances (Law, 1991). The term 'actor' can, therefore, be used to refer to a person, a plant, a machine, a weather system, or a germ (Whittle, A. & Spicer, A. (2008)). ANT's commitment to 'radical symmetry' involves viewing the power of humans and non-humans as equally uncertain, ambiguous, and disputable (Callon, 1986).

Furthermore, according to Pouloudi, A. et al., 2004 there is little generic guidance on how such relevant actors can be identified when a different research context is under study. Moreover, they went on further with arguing that they can be instrumental in providing a generic, context-free guidance to stakeholder identification that was missing from ANT studies (Whittle, A. & Spicer, A (2008).

IV- Methodological approach

The Methodological approach adopted in this paper builds on multiple proxies to develop the results.

In particular,

- A Geographical Information System (ESRI, to map the various green Buildings certified or in process of being certified by either one of the Green Rating Systems applicable in Lebanon

- A compilation of primary and secondary data compiled using available manuals and handbooks of the compared national and international Green Rating Systems. Primary data collected through interviews conducted with related Assessors of various rating systems.

- ANT maps visualization approach and a generic, precise, and well-defined notation directly mapped to key concepts of ANT as defined by Bengtsson & Lundstrom (2013). The maps show the connection between various actors relevant to their probable impact on the process flow.

V- Findings

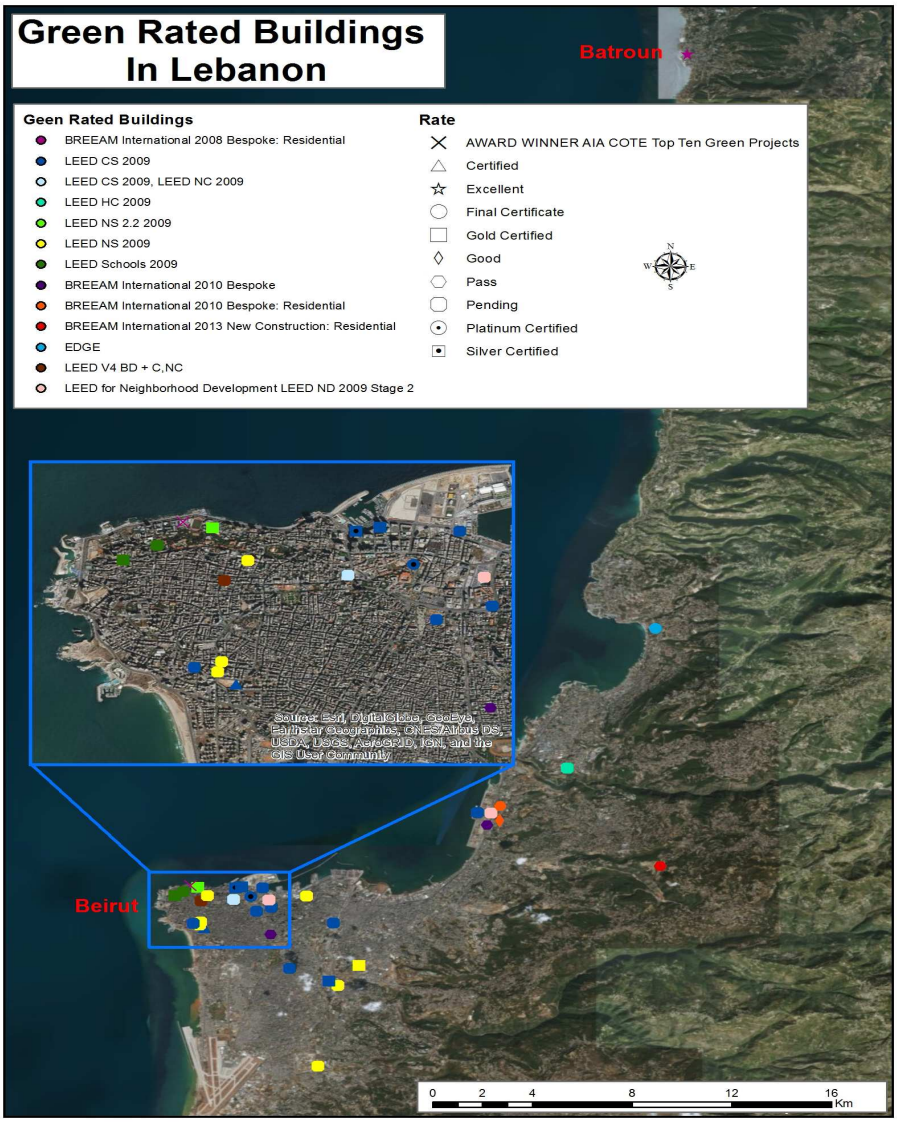
A comparative analysis between Green Rating Systems (table 1) components used in Lebanon shows that Green Rating Systems (GRS) are not mandatory, and they depend on client attitude awareness and willingness towards preserving the environment. GRS are booming most prominently LEED as it is more marketable and more effective in large projects which constitute a larger proportion of construction in Lebanon. ARZ is a recent national GRS (2011) applicable to domestic existing buildings thus limiting its target spectrum.

Table 1: A Comparative matrix of national and international Green rating Systems used in Lebanon (LEED, BREEAM, ARZ)

GBRS	Number of Buildings Certified	Established	STATUS	ORGANIZATION	Counties	TOTAL Credit Points
BREEAM	590,000 Buildings (BRE 2018)	1990	Voluntary	BRE (UK)	78	149
LEED	103,000(http://cdn.ifma.org/sfcdn/membership-documents/green-rating-systems-htg-final.pdf)	1998	Voluntary	USGBC (USA)	160	110
ARZ	<10	2011	Voluntary	LGBC (Lebanon)	1	166

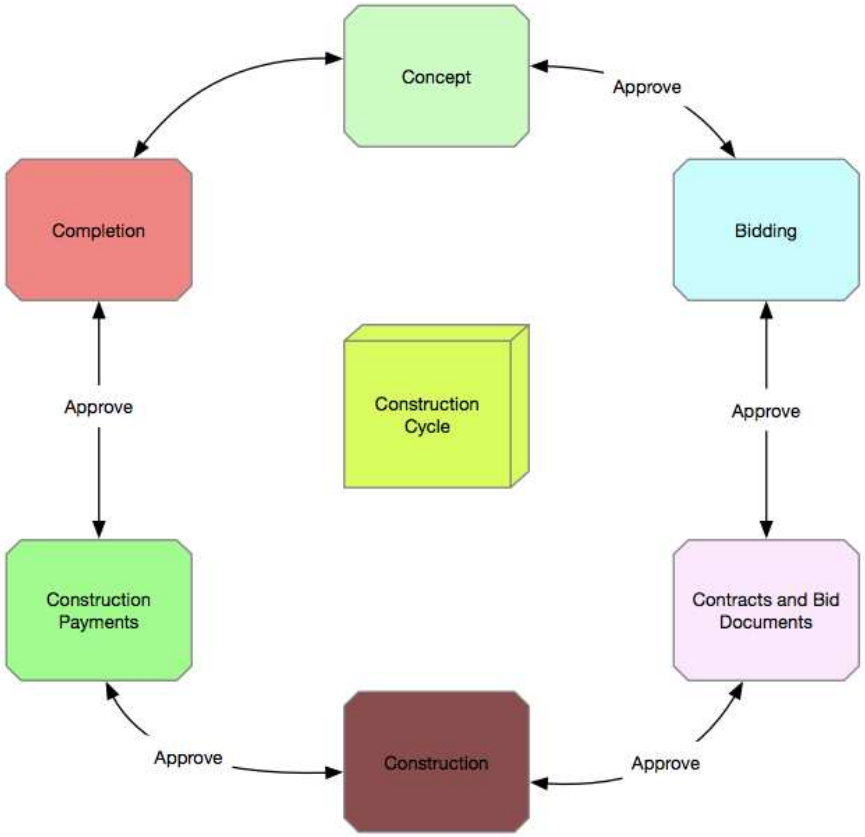
A geographical analysis of the distribution of green building either certified or pending as per the various rating systems adopted in Lebanon (figure 1) confirms that the dispersion and relatively minimal adaptation of national and international GRS. Certified Buildings are scattered in various areas in Lebanon however they are concentrated in the capital Beirut amounting to 29, this shows that only 47 initiatives have emerged in Lebanon since the year 2009.

Figure 1: GIS derived map showing the location of the Green Rated Buildings in Lebanon either certified or in process of certification.



The Complex construction flow process in Lebanon (Figure 2) encompasses many steps starting from pre-construction (design phase) to delivery. The Stakeholders' role play in the construction stages is a dynamic process where the impact of actors can be exasperated or minimized.

Figure 2: Construction flow process in Lebanon



Furthermore, along with the construction flow many external influential factors can intervene at different incidents affecting the flow of work, such as socio-political instabilities, financial incentives, corruption and bribery, government policies and regulations as well as the green building context encouraged by international movements.

The Influence of green/ Smart attitude of various stakeholders along the construction flow (figure 3), and the identification of inhibitors, facilitators, decision makers among the stakeholders shows the diversity in stakeholders and their preference. Furthermore, it illustrates the role of participants and their interventions in the process of construction. Taking the architect role as an example, into account we can clearly identify the critical role he/she has in influencing the building's orientation towards a green or a non-green track. Since their role is to create and monitor the project from its budding in the concept phase through to the implementation and ending with the delivery stage.

Figure 3: The influence of Green initiative of stakeholders along the construction flow.

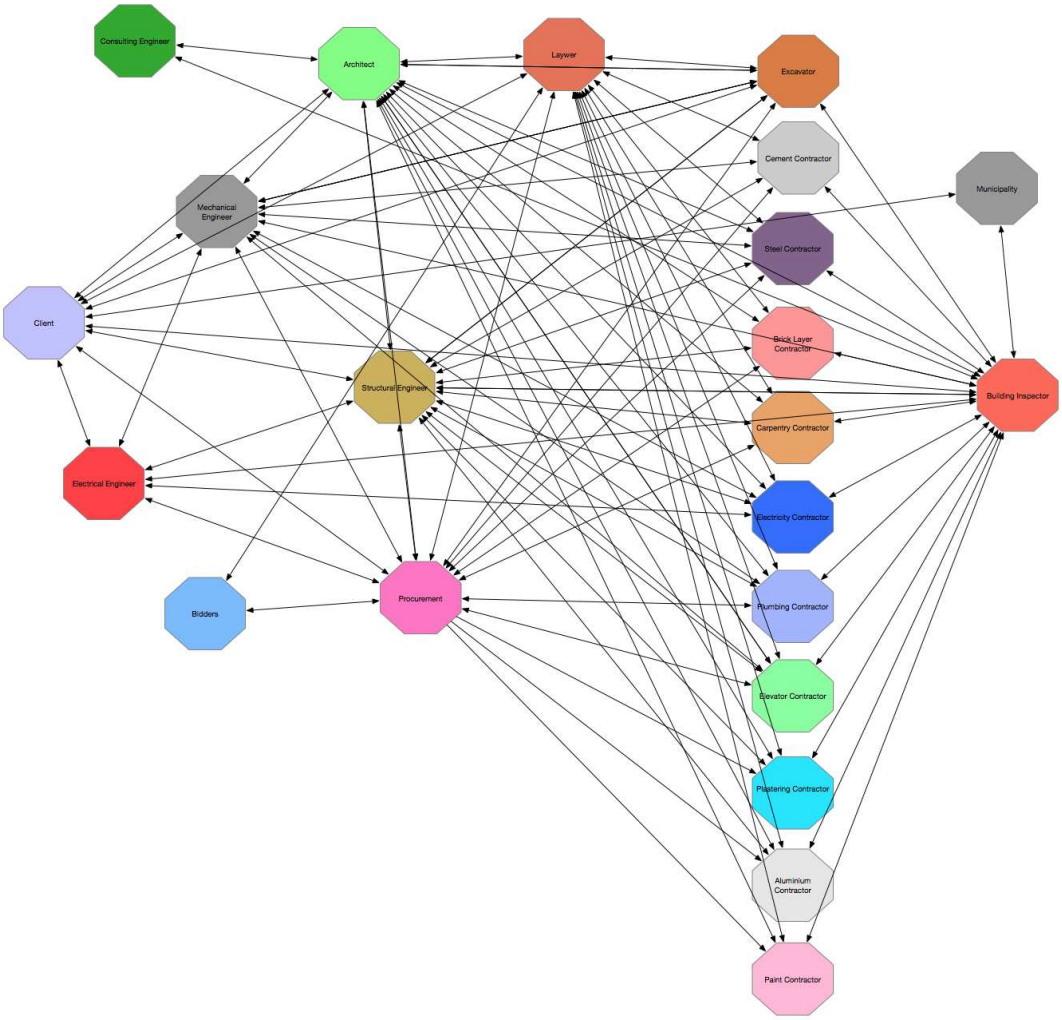
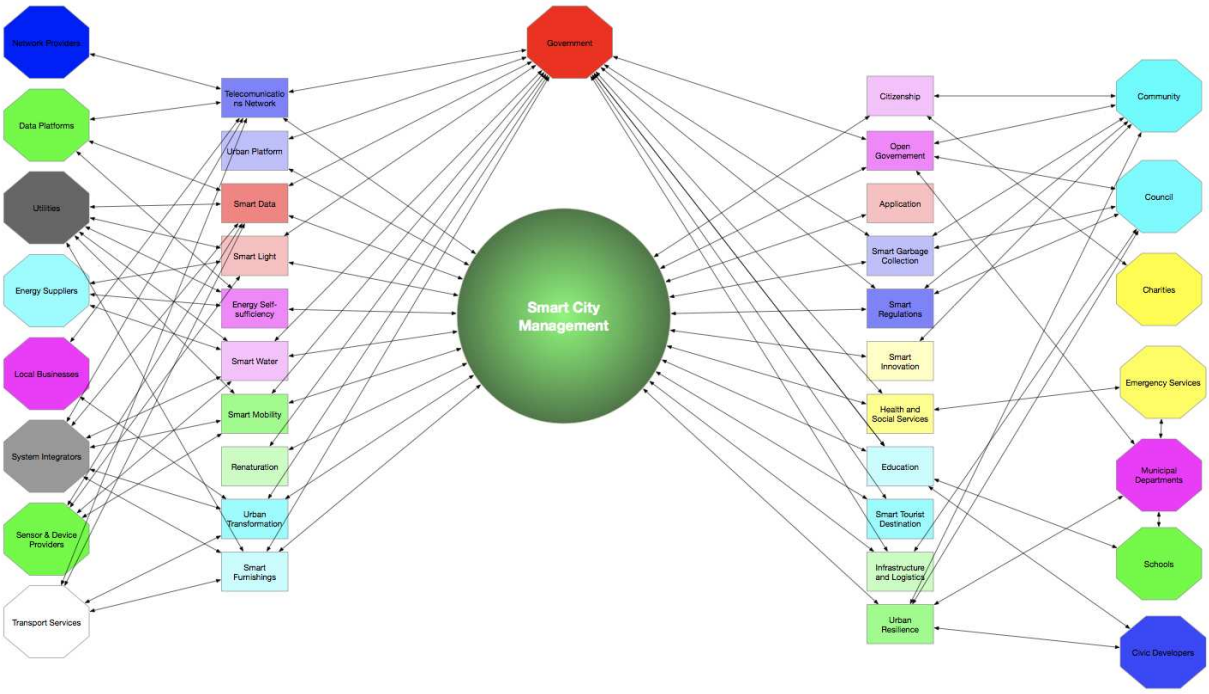


Figure 4: the identification of stakeholders' network in a smart city



The figure 4 shows the many roles different primary and secondary stakeholders have on the adoption or restriction of green/Smart attitude. The role of Governments, in this case, can either be the main facilitator or act as an inhibitor through not providing relevant investments or upgrades necessary to achieve smartness. In case of a lack of governmental initiative towards the establishment of Smart Cities and since they are a public vision which lawmakers must rally behind through setting an overall strategy to accomplish, the government can act as a bottleneck.

Discussion and Conclusion

The findings of this paper show that Green Buildings, certified under either LEED, BREEAM or ARZ rating systems represent an important step to establishing Smart Cities, however, their contribution to the overall pathway towards them remain very shy.

Green Rated Buildings in Lebanon confirm the emergence of an environmental awareness and initial achievement in the overall quest towards sustainability. However, those are still too few

and scattered to serve as a solid nucleus for the establishment of Smart Cities. Information systems notably servers, portals and clouds are crucial in shifting from green buildings to mart buildings and in a later stage to smart environmental neighbourhoods. A smart management of the urban environment is the starting point for effectively enhancing people's well-being and quality of life.

Existing and pending Green rated building can represent a potential stepping stone towards sustainable neighbourhoods where a diverse compilation of external and internal stakeholders such as retailers, NGOs, wholesalers, and neighbours collaborate on improving the living environment in which they co-exist in.

The path towards Smart Cities is mainly driven or in our case hindered by government will and/or lack of infrastructure. Nonetheless, it played a multi-facet role through providing several green initiatives wrapped up under the Lebanese Central Bank, in the form of green loans.

In this perspective, the Millennium development goals and in particular the SGD 11 on sustainable cities and neighbourhoods can only find its full meaning, in complex Mediterranean countries, when it blooms from streets to neighbourhoods and from neighbourhoods to towns, and from towns to Smart Cities at a later stage.

Society components such as creativity, social coherence, well-being remain the cornerstone and investing efforts on social and psycho-cognitive approaches as complementary tools to Information systems might pave this way sustainably.

This research provides an interesting path to integrated management of city neighbourhood in a perspective towards progressively establishing sustainable neighbourhoods, as a step towards smart neighbourhoods and Smart Cities.

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Appendix

Interviews

Candidate Name:	Fady Kasshanna	Position:	Surveying Engineer
Date of interview:	6 December /2019	Interest:	Role / importance / effect on overall Project
Stakeholder Type:	Technical		

Questions

1. Have you heard about ARZ LEED BREEAM rating system?

   No

2. Have you ever heard about a Green Rating system?

   Yes, during a meeting with the zgharta ehden municipality meeting

3. In your field of work have you ever considered a green approach?

   I haven't given it any thought.

4. Has any of your clients insinuated anything pertaining to green buildings?

   No , since real estate developers are more into utilizing their land investment to the max, without any regard to how green buildings are. They only care about money.

5. As a surveyor what is your role in the design planning and implementation construction processes.

   As an engineer we can have a profound effect on the desgin and even sometimes we can the affect the choice of whether the investor takes on a project or not. We can even sometimes push the investor to invest if we find out that any road or investment % is rising or not. (tesnif)

   We can furthermore alter the architect's design through terrain and shape of the land.

6. Can your results effect the design of a project

   As I previously mentioned yes.

7. In your opinion how can we promote green buildings and increase awareness.

   I think we should tell the investors and property developers all the information regarding green initiates and especially the financial ones.

8. In your opinion how can we facilitate the adoption of green approaches in Lebanon?

   We can give them incentives (as you told me regarding extra investment space , …) and reactivate the housing (esken) this is one of the most important factors. Furhtmore tell people about the benefits and increase bank facilities to people who choose this concept.

9. Do you require any information pertaining to the adoption of green approaches?

   We can research it, however in my area of expertise we are limited in our impact on the choice of going green or not, we can only effect the investment choice of a developer

10. How would you describe the future tendencies in Lebanon affecting commercial real estate

    I have no idea. Currently the economic situation is not favorable for normal construction.

11. How will a change in standards, rules and norms from conventional construction to green will aid in the adoption and shift current practices, How difficult is it?

    It will effect, positively or negatively depending on the manager of change and adoption . If it will be voluntary or by force.

12. Why aren't all buildings Built to be green in your opinion?

if people ask for it than a change in costumer (change in sizes of the apartments from a while back) people demanded lower prices as such smaller apartments, if customers change and want green than they will demand it and therefore shift.

Candidate Name:	Sara Ayyach Rahhal	Position:	LCEC
Date of interview:	8 August /2018	Interest:	Role / importance / effect on overall Project
Interview Topic:	Environment		

Questions

1- How many green rated buildings have ARZ certification and if possible their location.
{LGBC}- Five Buildings as listed below;

1. Rating 1st ARZ Rated building, BLC headquarters, Dec. 2011, Bronze Certification
2. Beta Engineering office received Bronze Rating with ARZ BRS, Feb. 2013 , Badaro
3. WaterFront City Offices, WFC, Bronze Certification, March 2015, Dbayeh
4. Reuters, Beirut Central District, January 2016, – **ARZ Certified Certification**
5. Order of Engineers & Architects, OEA Beirut, September 2016, **ARZ Bronze Certification**
6. ARZ Building Rating System – **Registration**,

Commercial Buildings company SAL , August2017
2- The potential cost for assessing an existing bldg in sqm . {LGBC} pls refer to www.arzrating.com →To clients→Fee Calculator
3- What are the criteria "check list" which the assessors abide by. {LGBC}pls refer to the attached booklet
4- What are the future objectives and schemes of ARZ {LGBC}extending the work and efforts to initiate ARZ rating system for new buildings
5- do you have monitoring plans?{Sara} recommendations and instruction to improve and upgrade the rated building to be issued by ARZ reviewer post the assessment procedure, after 5 years, clients can re-assess to upgrade their ratings.
6- do you have performance results and cost reduction after implementation?

Candidate Name:	Vahakn Kabakian	Position:	Ministry of Environment
Date of interview:	16 March /2018	Interest:	Role / importance / effect on overall Project
Stakeholder Type:	Legislation		

In comparison with sustainability development in the surrounding Arab countries, U.S, U.K. and the European Union member states, Lebanon seems to have taken some primitive steps towards the sustainability plan but a lot remains to be achieved yet so it can take a place among the leading countries in this field. Besides the scarcity of its natural resources, Lebanon has suffered from a long civil war that lasted about 15 years and thus brought the country under a heavy financial debt and hindered its economic growth. In fact, only 2.4 % of total public financial resources are allocated to environmental protection11. And of course green construction requires higher immediate investments than ordinary one which makes convincing developers and users of opting for sustainable construction a challenge. Here comes the importance of public awareness and recognizing the benefits of lower life cycle costs of green buildings. Thus it is mandatory to teach our generations about our environmental concerns, the importance of preserving our natural resources, and the urgent need to develop and enforce environmental regulations in order to protect our environment. Hence, green construction technologies and their effect on the environment as well as building codes and regulations should be introduced into our Civil Engineering curricular programs. Also, the media (visual or written) should help promote sustainability by dedicating enough time or space to talk about environmental issues, show their impact on our daily lives, and discuss the ways they can be addressed. In addition, the private and public sectors should both coordinate and create incentives to orient developers and users towards sustainable development such as discounts on environment-friendly materials and green construction technologies, rebates on solar panels, reduced interest on loans for green houses, etc. Another major barrier threatening the sustainable development in Lebanon is the lack of a proper legislative system responsible for enforcing and monitoring green construction practice. While the Ministry of Environment along with the Ministry of Energy and Water are trying to spread awareness through campaigns and other initiatives, the absence of a solid building code or regulations along with the absence of a credible monitoring agency represent the most challenging threat yet to overcome.

Candidate Name:	Antoine Dammous	Position:	Developer/ Engineering Consultant
Date of interview:	17 May /2019	Interest:	Role / importance
Stakeholder Type:	Economy		

- The government plays a key role in this regard and should at least enforce the minimum requirement of submitting an environmental impact assessment for new buildings to the corresponding authorities for approval.
- It should also ensure that at least public projects use components and construction practices that are energy efficient and environmentally sustainable so they provide a role model for the private sector.
- Another incentive that the government can initiate is to organize a Green City Award, similarly to the European Commission, in order to motivate Lebanese cities to compete for sustainability.
- Last but not least, cooperation and coordination of efforts between the governmental parties such as the Ministries of Environment, Industry and Public Works, the Council for Development and Reconstruction, the different NGOs such as LGBC and others, the developers, the educational and training institutions and the public is a crucial factor to face the current challenges and to put the country on the right and fast track towards sustainability.

Candidate Name:	MARIO SAAB	Position:	MANAGING DIRECTOR OF SEEDS COMPANY
Date of interview:	8 August /2018	Interest:	Role / importance / effect on overall Project
Stakeholder Type:	Environment		

we have 4 or 5 projects up to my knowledge already certified under LEED and BREEAM There's the new IC college, Beirut City Center, M1 building, B11 Beirut and Murex Office Building under LEED. And there's La broceliande residence & Casa Batroun

analysis of green rating system application and adoption in Lebanon predominantly between internationally applied Green Building Rating Systems; LEED and BREEAM, and one particularly developed for the nation; ARZ. Those three systems are analyzed

with respects to them addressing and prioritizing the environmental pillars stipulated in Cohen's smart city wheel. Furthermore, illustrates the limitations and adaptability to the nation, focusing on several criteria elucidated by the interviews conducted with adopters, assessors and several stakeholders.

- Limitations: of GBRSs' application and possible areas of improvement have been highlighted, such as climate change adaptability and the importance of sustainable communities and cities trend. The aim is to help designers and construction stakeholders in defining the development sustainability targets and objectives, without compromising on the local context and regional agenda.

- We're not talking about changing the whole economy using investment and policy towards people and businesses for the take that lower carbon and restore nature rather than degrade it the problem is politician don't acting at the speed or scale we need them to because I think the public wanting to do something else first fixing the infrastructure and build up a productive economy.

- Politicians are not putting the environment at the top of that list.

- my answer is we don't instead we show moving to a green economy worried about improves their lives when they care about the environment or not have a very different conversation with people because we need to make the case to rapidly move to a green economy at a time people are facing real economic challenges and we can't ask him to put that to one side we need to make the case economy at a time of rising populism.

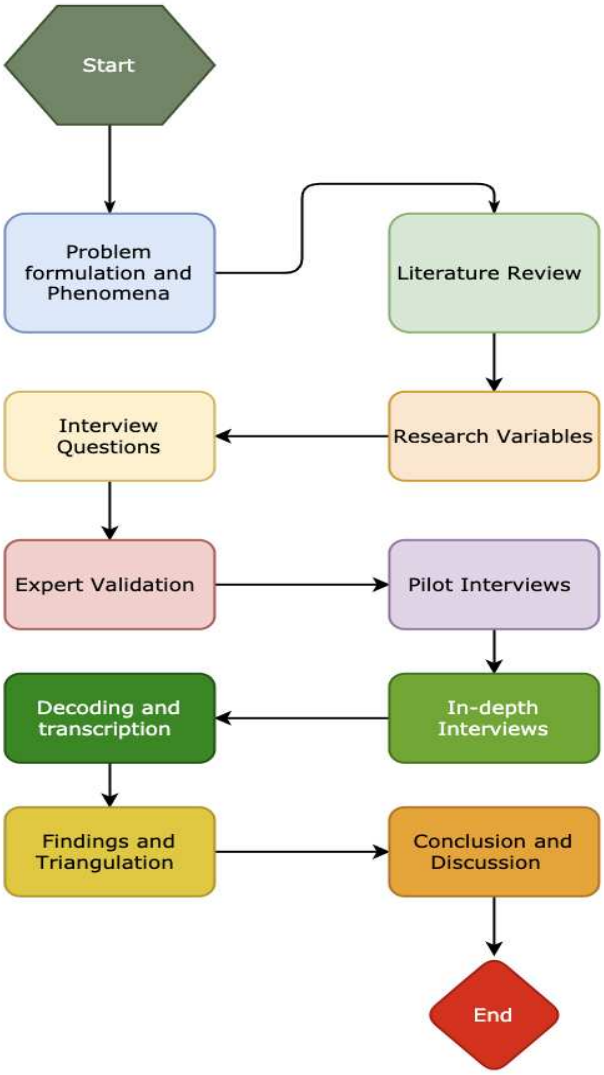
- We have to give people real Solutions instead so what does my perspective tell us and industrial City right in the middle of the country at the foot of the Peak District and the most beautiful countryside in the Beirut and I started my career in retail economics and has got the biggest differences in regional economic performance of any economy in the advanced world wealth is concentrated in London and we spend our time running the economy that's the only region that matters and that really frustrates people and it's really bad economics agriculture and manufacturing to the most important sectors for the environment that need to Pioneer new ways of producing goods and food sustainably being an economist I know that has not recovered since the financial crisis.

Appendix

System	Country of origin	Rating Schemes	Certification Levels	Points or Percentage allocation
BREEAM	United Kingdom	·Communities ·Courts ·Education ·Health care ·Homes ·Industrial ·International Multi-residential ·Offices ·Prisons ·Retail ·Other	 ·Outstanding ·Excellent ·Very Good ·Good ·Pass ·Unclassified	• •≥85% •≥70% •≥55% •≥45% •≥30% •<30%
LEED	United States	·Building Design and Construction ·Interior Design and Construction ·Building Operations and Maintenance ·Neighborhood Development ·Homes	·Platinum ·Gold ·Silver ·Certified	•85+ Points •60 to 79 Points •50 to 59 Points •40 to 49 Points
ARZ	Lebanon	·Existing Buildings	·GOLD ·Silver ·Bronze ·Certified ·Non-Certified	•135 Points •120 Points •100 Points •80 Points •<80 Points
Estidama	UAE	Buildings Villas Neighbourhood	•1 Pearl •2 Pearl •3 Pearl •4 Pearl •5 Pearl	•+60 Credit Points •+85 Credit Points •+115 Credit Points •+140 Credit Points
GSAS	Qatar		•1 Star •2 Star •3 Star •4 Star •5 Star •6 Star	•

Table 4. Comparison Between International and National Green Rating Systems

Appendix 7


Start
Problem formulation and Phenomena
Literature Review
Interview Questions
Research Variables
Expert Validation
Pilot Interviews
Decoding and transcription
In-depth Interviews
Findings and Triangulation
Conclusion and Discussion
End

Appendix

Name	Location	Description	Area Sq Ft	GRS	Rate	CREDITS	DATE	Latitude	Longitude
ABC VERDUN	VERDUN	EcoConsulting ltd (Retail)	827,743	LEED CS 2009	Certified	44 pts	30/03/2018	33.88434385	35.48503759
B13	Beirut	International Hotel Investment Company (Multi-Family Residential	276,587	LEED CS 2009	Silver Certified	52 pts	26/03/2018	33°54'2.66"N	35°29'59.31"E
BD 1227	Beirut	ZRE SAL (Office)	21,223	LEED CS 2009	Registered	Pending	23/05/2017	33°53'39.05"N	35°30'14.04"E
Beirut City Museum	Beirut	Solidere S.A.L. (Public Assembly)	59,301	LEED V4 BD + C/NC	Registered	Pending	04/05/2017	33°53'52.38"N	35°29'10.17"E
International College PreK Renovation	Beirut	International College (K12)	20,128	LEED Schools 2009	Registered	Pending	07/04/2016	33°53'58.34"N	35°28'39.44"E
Kattaneh landmark	Beirut	EcoConsulting ltd (Other)	236,277	LEED NS 2009	Registered	Pending	23/03/2016	33°53'51.82"N	35°31'19.33"E
MANI CRY ENGINEERING COMPULK	Beirut	Higher Education /AUB/FPDU (Higher Education)	130,857	LEED NC 2.2 2009	Gold Certified	40 pts	23/04/2015	33°54'5.25"N	35°28'58.24"E
Mina 1,304	Beirut	Investor / Lasa Co (Office)	62,457	LEED CS 2009	Gold Certified	56 pts	25/07/2014	33°54'2.66"N	35°29'59.21"E
Dar Beirut Headquarters	Beirut	Dar Al Handasah Real Estates S.A.L (offices)	355,209	LEED NS 2009	Registered	Pending	23/06/2014	33°53'12.46"N	35°29'1.26"E
North Souks Department Store	Beirut	Solidere S.A.L. (Retail)	379,824	LEED CS 2009	Registered	Pending	09/04/2013	33°54'3.37"N	35°30'13.06"E
Spot-T Tayaneh Mall	Beirut	Phoenician Holding (Office)	323,092	LEED CS 2009	Registered	Pending	05/03/2013	33°52'2.18"N	35°30'57.12"E
AUBMC Academic Clinical Center	Beirut	AUH Academic Clinical Center (office)	267,914	LEED NS 2009	Registered	Pending	05/02/2013	33°53'52.38"N	35°29'10.17"E
Olive Residence	Beirut	1442 Ras Beyrouth,SAL(Multi-Family Residential)	258,250	LEED NS 2009	Registered	Pending	05/09/2012	33°53'8.42"N	35°28'50.33"E
District/S CC	Beirut	Saifi Modern SAL (Public Assembly	27,001	LEED NS 2009	Registered	Pending	22/05/2012	33°53'45.76"N	35°30'30.34"E
Rive Gauche	Beirut	Rive Gauche (office)	207,048	LEED CS 2009	Registered	Pending	12/05/2012	33°53'11.17"N	35°31'54.02"E
Saifi 178	Beirut	Solidere (Multi-Family Residential)	124,743	LEED CS 2009	Registered	Pending	14/04/2012	33°53'34.45"N	35°30'33.00"E
District/S CC	Beirut	Corporate Saifi Modern SAL(Neighborhood Development)	3	LEED for Neighborhood Development LEED ND 2009 Stage	Registered	Pending	27/08/2011	33°53'45.76"N	35°30'30.34"E
Aramex Warehouse	Beirut	Corporate Aramex (warehouse Distribution)	63,968	LEED NS 2009	Registered	Pending	20/12/2010	33°51'36.46"N	35°32'0.16"E
Beirut Harbor 1506 Marfaa SAL	Beirut	Corporate SFG (Multi-Family Residential)	107,777	LEED CS 2009	Registered	Pending	30/08/2010		
Verdun Heights	Beirut	Investor/S (Multi-Family Residential)	555,208	LEED CS 2009	Registered	Pending	23/06/2010	33°53'10.18"N	35°28'52.13"E
Charles Hostler Student Center	Beirut					AWARD WINNER AIA COTE Top Ten Green Project	01/01/2009	33°54'7.30"N	35°28'48.25"E
Lot 1031 Rmeil	Beirut			BREEAM International 2010 Bespoke	Good				
Tohen Rok Office Building	Ibeli (Mount Lebanon)	Office	10,010	EDGE	Certified	EDGE	10/02/2015	34° 6'54.10"N	35°40'23.66"E
Promenade Residences 1 to 4	Dbayyeh	EcoConsulting UK Ltd (Residences)		BREEAM International 2010 Bespoke	Pass			33°55'57.52"N	35°35'0.67"E
Plaza Residences 1 to 3	Dbayyeh	EcoConsulting UK Ltd (Residences)		BREEAM International 2010 Bespoke	Pass			33°52'54.37"N	35°30'32.52"E
Beirut City Centre	Beirut	Corporate Majid Al Futtaim (Retail)	1,037,723	LEED CS 2009	Gold Certified	52 pts	09/12/2013	33°53'42.80"N	35°31'47.35"E
M1 building	beirut	Corporate Mikati Real Estate (Office)	212,958	LEED CS 2009	Platinum Certified	81	20/07/2016	33°53'56.32"N	35°30'0.77"E
International College Elementary School	Ras Beirut	Higher Education /International College (Higher Education)	244,017	LEED Schools 2009	Gold Certified	61 pts	18/03/2013	33°53'52.57"N	35°28'27.35"E
Associated Consulting Engineers New HQ	Matn	Corporate /ACE International (Office)	57,962	LEED NS 2009	Gold Certified	61 pts	15/02/2017	33°52'7.08"N	35°32'26.85"E
Residences la Brocallande				BREEAM International 2008 Bespoke	Very Good				
Lebanon Waterfront City LWFC	Matn	Waterfront City SARL (Neighborhood Development)	85	LEED for Neighborhood Development LEED ND 2009 Stage	Registered	Pending	09/05/2013	33°55'57.52"N	35°35'0.67"E
LWFC Residential Phase 1	Matn	Waterfront City SARL (Residential)		BREEAM International 2010 Bespoke: Residential	Pass			33°55'57.52"N	35°35'0.67"E
Casa Batroun	Batroun			BREEAM International 2008 Bespoke: Residential	Excellent			34°15'6.65"N	35°39'34.02"E
Residences la Brocallande				BREEAM International 2008 Bespoke	Pass				
BeitMisk Phase 3	Aytchane	BeitMisk		BREEAM International 2013 New Construction: Residential	Pass			33°54'37.58"N	35°38'58.31"E
LWFC Residential Phase 3 Type 2 SP5	Matn	Waterfront City SARL (Residential)		BREEAM International 2010 Bespoke: Residential	Good			33°55'57.52"N	35°35'0.67"E
Keserwan Medical Center	Ghazir	AMC SAL (Hospital)	58,371	EDGE	Final Certificate	Final Certificate	02/03/2015	33° 0'37.48"N	35°38'52.44"E
Beirut Terraces	Beirut	Multi-Family Residential Building	1,023,000	LEED CS 2009, LEED NC 2009	Registered	Pending	20/11/2009	33°53'46.56"N	35°28'46.13"E
Mouseya Hotel	Aramya	Lodging Building	11,085	LEED NS 2009	Registered	Pending	04/08/2011		
LDS Office Building	Matn	Office Building	18,309	LEED NS 2009	Registered	Pending	02/10/2008		
Lebanese Canadian University	Hadath	Higher Education	150,180	LEED NS 2009	Registered	Pending	03/11/2014	33°49'34.80"N	35°31'16.28"E
RED Headquarter Buildings	Matn	Office	45,835	LEED NS 2009	Registered	Pending	25/08/2014		
Business Park SP2	Dbayeh	Business Park	140,000	LEED CS 2009	Registered	Pending	20/05/2015	33°55'57.52"N	35°35'0.67"E
Alvoo Business Park	Hazmieh	Business Park	212,049	LEED CS 2009	Registered	Pending	23/02/2010		
LAU Library and Central Administration	Byblos	Higher Education	80,403	LEED NS 2009	Registered	Pending	20/06/2013	34° 6'54.10"N	35°40'23.66"E
NDU Medical Center	Zouk Mosbeh	Hospital	430,809	LEED HC 2009	Registered	Pending	26/11/2014	33°57'5.57"N	35°35'7.77"E
International College AA Gym and Theater	Ain Aar	School	37,501	LEED Schools 2009	Registered	Pending	07/04/2016	33°53'58.34"N	35°28'39.44"E
BLC headquarter	BEIRUT	BANK		ARZ	Certified	Bronze Certification	40878	33°52'40.68"N	35°31'7.23"E
Ibis Hegenning «Elie»	badaro	Office		ARZ	Certified		41806	33°52'21.54"N	35°30'45.47"E
LWFC	Matn	Waterfront City SARL (Residential)		ARZ	Certified	Bronze Certification	42084	33°55'57.52"N	35°35'0.67"E
Kreiter	BEIRUT	Office building		ARZ	Certified	certified	42370	33°53'55.12"N	35°28'38.89"E
Order of Engineers & Architects, OEA Beirut	BEIRUT	Office Building		ARZ	Certified	Bronze Certification	42614	33°52'25.36"N	35°29'38.00"E
Commercial Buildings company SAL	BEIRUT	Office Building		ARZ	Certified	certified	42948	33°53'44.85"N	35°30'16.62"E

Appendix

Table 1: Interview Respondents' profile according to their pertinent Group, Type and question objectives.

Group of STAKEHOLDERS	Type of Stakeholders	Respondents	Objectives of the Questions
Economy	Resource Element	United Nations / European Union / Arab league of Nations international and national NGO	International Incentives related to green initiatives. Lebanon's in global trend towards sustainability
Environment	Assessor	(SEEDS) LEED/ BREEAM/ARZ Assessor	Compile information of current and future project regarding Green buildings trends in National and regional
Legislation	Government	Ministry of Environment (Mark / Vahakn Kabakian	Government information and future incorporation of green construction and incentives in Lebanon.
Environment	Resource Element	Order of Engineers and Architects	GRB incentives / Training Requirements (Gap analysis) / Marketability/ Current trends in Green Construction.
Design	Resource Element	Architect	Current and future Green trends, Stakeholder management/ scope management/ green inference in the construction flow
Design	Resource Element	Chief Engineers	Training Requirements/ Client management, Role of the Chief Engineer in the construction project. Impact of various stakeholders on the project outcome.
Legislation	Resource Element	Lawyer	Warranty Requirements/ Legal Requirements. Role in the construction process/

Group of STAKEHOLDERS	Type of Stakeholders	Respondents	Objectives of the Questions
Economy	Capacity Element	Real Estate agent DEMCO properties	The market indicators which they follow in order to initiate a project. The criteria they follow to choose the area of investments. Standards on which they work.
Economy	Capacity Element	Property developer	Assessment of internal and external environmental factors. The effect of barriers and incentivize ion the overall choice pertaining to green construction.
Economy	Resource element	Commercial Bank	The indicators by which they grant loans. Green Loans. Green initiatives. Green Facilities.
Economy	Resource Element	Lebanese Central Bank	Role of the BDL in the construction sector in Lebanon. Incentives. Barriers. Criteria through which they choose to aid a particular project. The promotion of National GRS instead of International.
Environment	Assessor	Assessor	Role/ facilitator/ impact of his opinion/ power
Design	Resource Element	Mechanical Engineers	Acoustical/Heating/Ventilating Requirements of green vs non-green buildings/ Innovation in construction / difficulty of constructing green building/
Design	Resource Element	Electrical Engineers	Requirements of Green buildings, green influences, role as a stakeholder,
Design	Resource Element	Structural / Civil Engineers	Requirements of Green buildings, green influences, role as a stakeholder,
Design / Legislation / Environment / Social	Resource Element	Consultants	Requirements of Green buildings, green influences, role as a stakeholder,

Group of STAKEHOLDERS	Type of Stakeholders	Respondents	Objectives of the Questions
Economy	Capacity Element	Contractors	Implication of a green approach on their overall bid. Requirements. Factors that affect their overall performance. How they look at green buildings.
Design	Resource Element	Quantity Surveyor	The differences between a green and a non-green approach on the quantity and type of material utilized. The relationship with other stakeholders (primary and secondary)
Social / Environment/ Design	Resource Element	Project Managers	Opportunities and threats as a result of green buildings, effect of internal and external stakeholders on the flow of the project. Complexity of managing and engaging with stakeholders. criteria which abides by in order to reach the required outcome
Legislation / Environment	Government/ Resource Element	LCEC	What are the opportunities that this organization provide in congruence with the government can relay in order to push developers and clients to go green. Legislation and standards they are adopting.
Environment	Assessor	ARZ Rating System	the opportunities and threats facing a national rating system, the challenges facing, what are the barriers facing developers towards going green. future stances for ARZ. Effect of international Green Rating systems on the national market

Topic	**Social and education**	**Environment**	**Legislation**	**Economy**

Group of Stakeholders	Media Education Institutions	Information Education Standards and rules	Governmental	Incentives Recognition Cost/risk Industry
Type	News agencies Universities Customers	OEA LEED/BREEAM Assessors ARZ Assessors	Ministry of Environment MEW IDAL MPW CDR LCEC	Developers Banks Kafalat NGO BDL
Respondents	Universities Lebanese University USJ Balamand University		United Nations/ European Union / Arab league of Nations .. international and nationational NGO LCEC Minister	
Interviewee	Dr Micheline Wehbe	Fadi Kasshanna Mario Saab Arz Assessors	Vahaken Sarah	Antoine Dammous