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Building Transformation for Precautionary Measures against COVID-19 Pandemic: Case of Off-Street Car Parking of Campuses

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Abstract: COVID-19 set off a problem for businesses due to an unbalanced utilization of buildings, services, and utilities. Thus, some countries reduced the length of the quarantine period and returned to natural life earlier than necessary to allow the economy and businesses to survive. This research aims to review the standards of off-street car parking (OSCP) for higher education institutes (HEIs) and examine the possibility of the transformation of the car parking buildings. Secondary and descriptive research approaches have been applied, and OSCP standards of different countries have been reviewed to identify the challenges facing the transformation design process in terms of standard dimensions, finishing materials, building envelope, illumination, ventilation, and technical installations. OSCP of Kingdom University (KU) in Bahrain has been analysed for proposing the rescheduling of space planning and accommodating a certain number of in-person attendance students as per the three situations of the COVID-19 pandemic. The author concluded that OSCP spaces of the HEIs are the most feasible building for design transformation in terms of rescheduling the space planning, but it is not very achievable in terms of affordability due to much adaptation being required and additional technical installations. At least 68% of the area of OSCP is used for circulation and services. Future studies seeking the feasibility of smart rotary car parking to save such a huge area of car circulation in the traditional OSCP building are recommended.

Keywords: COVID-19 pandemic; off-street car parking (OSCP); transformation design; campus

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1. Introduction

COVID-19 has affected the utilization of most types of buildings: some were left empty, and some were overused [1]. This situation caused an unbalanced utilization of buildings, services, utilities, and interior functions [2]. Furthermore, there were negative economic effects on businesses [3]. This problem forced some countries to reduce the length of the quarantine period and return to natural life earlier than necessary for the economy and businesses to survive [4]. Such a forced decision increased the expected number of deaths [5]. Standards of campuses in various countries demonstrate that off-street car parking is one of the vital buildings in the HEI campuses in terms of area and cost [6–12]. Therefore, it is presently required to review the transformation, adaptation and flexibility design approaches that could be applied in the design of such a building. Although there are many studies and research concerning the transformation, adaptation, and flexibility of architecture, there are still not enough detailed design guidelines concerned with the adaptation of huge areas of car parking to be used according to different circumstances. The reasons for these insufficient guidelines are (1) focusing on users' participation in the design process of the transformation-based design approach; (2) greater attention given to the architectural devices rather than architectural spaces in the adaptation-based design approach; and (3) concentrating on building extension rather than multi-function spaces in the flexibility-based design approach. This above-mentioned statement is a result of the revision of research articles where a few of them discussed general principles of the transformation, adaptation, and flexibility design approaches. Transformation design is defined as an interdisciplinary human-centred method of creating sustainable changes in the behaviour and form of persons and organizations [13]. Colin Burns and others stated that design never ends because of constant changes in the environment. Therefore, the design must respond to current and constantly changing issues to produce adaptive architecture that is able to change according to ongoing requirements [14]. Asefi stated that the main requirement for buildings is the ability to respond to the changes in users' needs by involving them in the design decision. He argued that most recent studies recommended the integration of functional and technical solutions to achieve the transformable design. However, the significance of the transformable design is the beauty and simplicity of the mechanism [15]. A thesis conducted by Schmidt emphasizes the fact that changes in the building might occur after the construction process, so the architect must expect such changes and design adaptable buildings [16]. Brand believes in the static nature of architecture and that even the buildings can be adapted by architects and people [17]. However, Schnädelbach has confidence in building dynamics, so he classified the architecture adaptation into three levels and stated that all buildings are adaptable on one of these levels to respond to changes in circumstances: rapid change level of adaptation to deal with different activities in one day, medium-term change level through re-organization of the building, and long-term change level that requires adaptation of the building as its context surroundings [18]. Building adaptation usually requires exploring technology to solve traditional issues [19]. Adaptation also responds to different climatic sessions for a specific environment and inhabitants [20]. In addition to the environment-based and inhabitants-based adaptation, functional requirement adaptation has become popular and applicable which gives the dynamic characteristic to the architecture [21]. Megahed recommended further research and appropriate strategies during the design process to achieve flexibility and an efficient mechanism of architecture devices for adaptable buildings [22]. The open building and extendable core are two designs approached for flexible design [23]. The open building is suitable for horizontal extension to integrate indoor and outdoor spaces, but the extendable core, "which is known as add-in and add-on", is suitable for both horizontal and vertical extensions [24]. Adding new space and replacing a space are the two methods that are used in both open building and extendable core design approaches [25]. It is correct to say that the principles of transformation, flexibility, and adaptation are very important and applicable to the architectural design of any building, especially the large floor area of off-street car parking. This kind of building must be designed to respond to ongoing needs and continuous changes in the circumstances of the building, users, and environment.

2. Materials and Methods

Because the main source of the announced precautionary measures to prevent COVID-19 is World Health Organization (WHO), they are almost similar for all countries. Namely, vaccination as soon as possible, the social distance of at least 1 m, natural ventilation, wearing a face mask, cleaning and sanitating hands, covering coughs and sneezes and staying home when sick [26]. This research focuses on the social distancing precautionary measure as it is related to architectural design. Each country adopted precautionary measures to fit its purposes. For instance, Bahrain developed an Alert Levels of Traffic Light System, in which four sets of precautionary measures are implemented at four levels of the pandemic. The level changes depending on the rolling average of positive cases in intensive cases, as shown in Figure 1 [27].

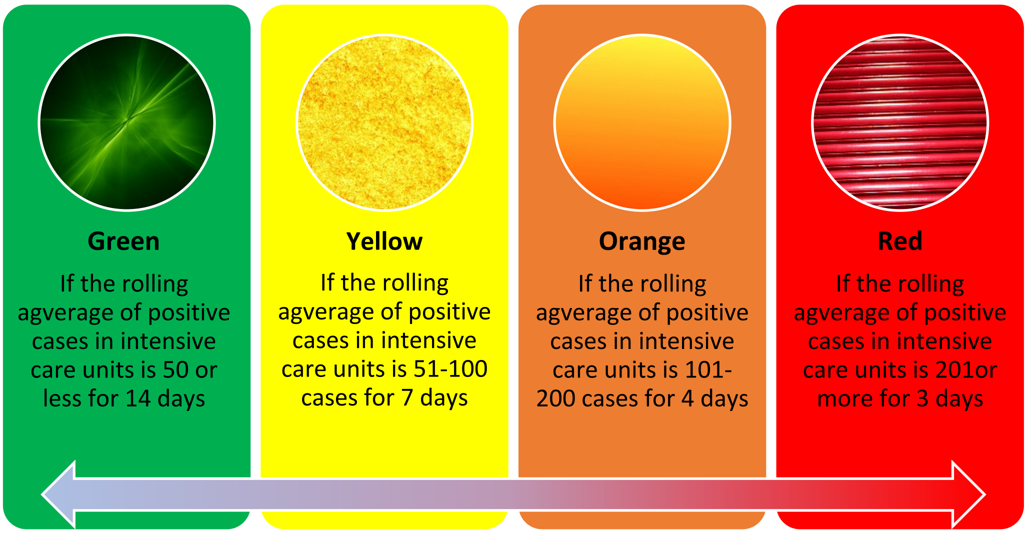


Figure 1. Alert Levels of Traffic Light System for COVID-19 in Bahrain.

In this research, the author deployed the secondary and descriptive research approaches. Secondary research has been conducted using data about design guidelines for off-street car parking in different countries, including Bahrain, Egypt, the USA, Canada, Australia, and the UK. Such guidelines are the standard dimensions, and car parking rates for HEIs campuses are collected and discussed. The outcome of this research method is the identification of the conceptual inputs of car parking design standards and the challenges facing the transformation design process of the car parking in terms of standard dimensions, finishing materials, building envelope, illumination, ventilation, and technical installations. The descriptive research has been applied for analysing the case of the car parking building of KU in Bahrain based on as-built drawings and site measurements and observations. The descriptive analysis included spaces, dimensions, and capacity of all existing buildings of the KU campus, building envelope and its performance for thermal insulation, methods of illumination, ventilation, air condition, and finishing materials and installations. The author introduced a proposal for adapting the car parking building of KU, including the spaces' rescheduling and technical adaptation requirements. The proposal takes into consideration the precautionary measures of the alert levels of traffic light systems for different situations that were developed by (NMTC-COVID-19) The National Medical Taskforce for Combatting the Coronavirus (COVID-19).

3. Results

3.1. Design Principles of Off-Street Parking

Car parking standards are needed to determine the details of minimum rates, dimensions, areas, and configurations of many variables, such as parking lots, parking aisles, circulation roads, accessways, manoeuvres, and ramps. The main inputs of defining such standards are rates of vehicle ownership, vehicle standards, user needs, peak hour vehicle movements, and turn-over frequency which are variables of the function of the building served by the off-street car parking. The main design considerations for off-street car parking are usually mentioned in the traffic guidelines manuals that are developed by each country considering its context. For instance, in the Kingdom of Bahrain: design the entrance and exits with minimum disruption to through-traffic and maximum pedestrian safety at the frontage roads of the off-street car parking development; design parking aisles and circulation roadways with adequate capacity for the peak period movements of the parking development; configure the internal roadways avoiding conflict in the traffic intersections, develop the master plan of the off-street car parking with minimum distance between the entrance and exit points; develop safe solutions for intersections of vehicles roads and pedestrian passages; provide parking spaces with specific dimensions for disabled people; and ensure continuity of pedestrian paths to access all parking and building entrance points [28]. The off-street car parking design faces the challenge of achieving land-use efficiency by providing maximum numbers of parking lots in minimum areas and adhering to the concerned standards and regulations [29]. In March 2004, Australian and New Zealand Joint technical committee issued the standards AS/NZS 2890.1:2004 that concerned the off-street car parking, in which the committee stated that providing safe pedestrian passages is a vital design consideration to achieve the intended function of the car parking. All types and sizes of car parking must be designed taking into consideration a clear definition of the safe pedestrian routes; distinctive colour for the pedestrian areas; safe pedestrian passages between the car parking and the other buildings; high-quality lighting with a 50 Lux minimum; and wayfinding signage. Design considerations for the small size car parking in addition to the previously mentioned are stated as follows: provision of one or more vehicle crossings on the exits and entrances; Design the circulation roads to avoid reversing manoeuvres back onto the main road; create landscape areas that mitigates the side-effects of CO_2 emissions on the environment; Suitable monitoring the parking area to prevent parking in circulation passages; and parking spaces allocation for mobility means to access the building it serves. Moreover, the large size car parking should be designed with the following additional considerations: design the circulation roadways and gates to avoid queues back onto the public roadway and plan such large parking for only long-stay and/or frequent users to obtain the efficiency [30]. The office of the Victorian Government Architect stated seven design principles of car parking buildings: inspired design that has a positive impact on the building to adjacent developments; contextual design that responds to the social, cultural, and environmental contexts of the site; functional design that creates synergy between architectural and technical functions of the building; valuable design that has a mixed-used to provide economic and social benefits; sustainable design that promotes efficiency, enhances ecology, and creates long-standing bequest through its adaptability to rapid updates of technology, use of renewable energy, water recycling, and integration of greens and landscape; enjoyable design that provide safety and attracts all peoples at all times; durable design that achieves the future vision and promotes the community pride [31]. From the above-mentioned design considerations, the car parking building design considers almost the same design considerations of any other building, including accessibility, safety, functionality, sustainability, and site context responses.

3.2. Standards of Off-Street Parking

As Table 1 illustrates, the common standard of the required number of car parking spaces is a space for every academic staff, a space for every two-admin staff, and a space for every four students. Applying this standard outcome huge number of required car parking spaces in the campuses' buildings., i.e., in the space programming of the KU new campus project, the required number of car parking spaces is 1056 to serve 2830 undergraduate students, 140 postgraduate students, 117 faculty members, 40 admin staff, and 18 technicians. These standards are decided for adhering to the HEC requirements. The required car parking spaces occupied 59% of the total built-up areas. The high cost of this percentage of built-up area for the car parking needs a smart design of car parking to enable multi-use of this kind of building, especially in the exceptional circumstances.

The configuration of car parking plots in different angles according to the standard dimensions is illustrated in Table 2. The car parking developers decide the angle according to the available distances for the width of the bay and the possibility of using wheel stoppers.

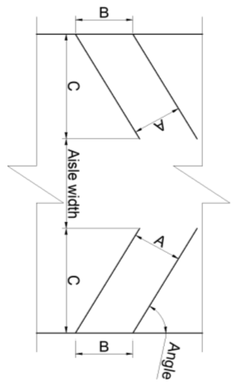
Table 1. Standard of Number of Parking lots for Campuses.

Country	Reference Name	Number of Lots
Bahrain	Higher Education Council (HEC) [6]	1 space/Academic staff 1 space/2 Admin staff 1 space/3 technicians 1 space/5 undergraduate students 1 space/postgraduate student 1 space for visitors/directorate 1 space for visitors/Academic staff 1 space/15 persons in MPH
	Building Permit code [7]	1 space/4 students
USA	Code of Ordinances [8]	1 space/employee 1 space/faculty member 1 space/2 students
UK	Parking Standards [9]	1 space/teaching staff 1 space/2 ancillary staff 1 space/4 students over age 17 One-third of total staff provision for visitors
Wales-UK	Car Parking Standards Part 1 of 2 [10]	1 space/member of teaching staff 1 space/2 ancillary staff 1 space/3 students 5 visitor spaces
USA	Parking Principles [11]	0.2 space/student (Good transit access) 0.5 space/student (Auto Access only)
Egypt	Egyptian Code [12]	0.2 space/student

Table 2. Standard of parking lots area.

Angle of Bay	A	B	C1	C2	C3	Aisle Width
90°	2.6	2.6	5.4	4.8	5.4	5.8
60°	2.6	3	5.7	5.1	6	4.3
45°	2.6	3.7	5.2	4.8	5.7	3.5
30°	2.5	5	4.4	4.1	4.9	2.9

Layout



In 90° bay A = B

Notes:
Dimensions in the table are in metres;
The above standards are for the short-stay parking types that are required for campus developments;
C1: where the planning is not allowing for any overhanging;
C2: where the planning is allowing for 60 cm overhanging;
C3: where the planning is not allowing for any overhanging and the parking is controlled by wheel stoppers.

Data sources: [28,32].

3.3. Pre-COVID 19 Plans of Existing Building at KU Campus, Bahrain

3.3.1. The Spaces and Dimensions

The campus of KU in Bahrain consists of five buildings, Buildings A and B are used for academic and administrative purposes that are constructed in seven stories with a total built-up area of 5800 m^2.; Building C is also used for academic and administrative purposes that are constructed in six stories with a total built-up area of 7850 m^2; Building D is used for workshops that are constructed in a single story with a total built-up area of 360 m^2.; and Building E is used for car parking and sports hall that is constructed of four floors with a total built-up area of 13,865 m^2. Moreover, 12,291 m^2 are car parking and 1274 sports facilities. According to resolution no. 4 issued in the 2007 regulation for regulating the building of higher education institutions in Bahrain, the capacity of the existing building is 1362 students. Figure 2 and Table 3 show details of spaces and capacity.

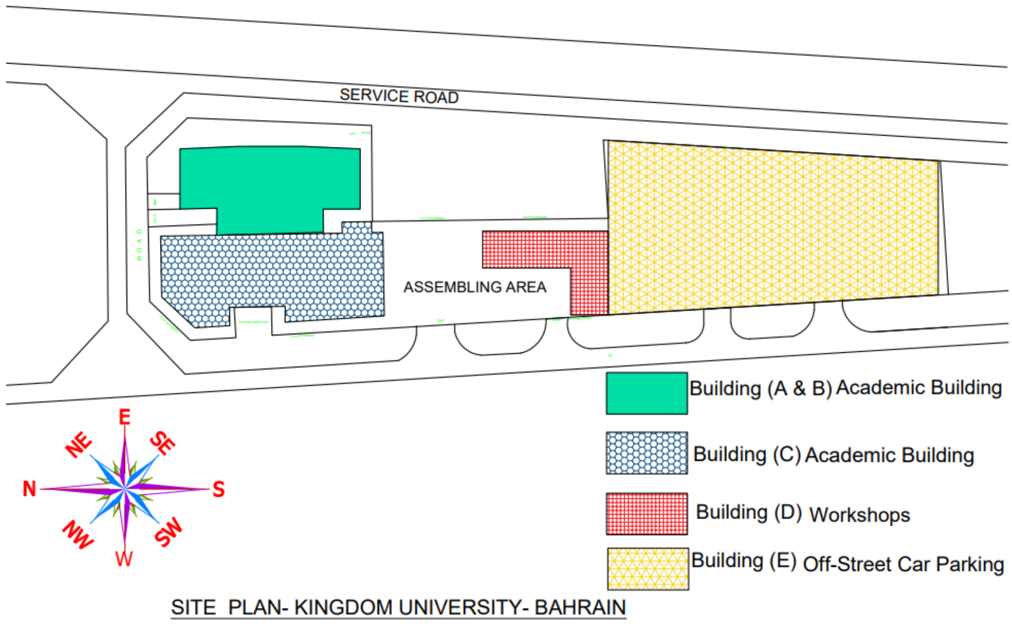


Figure 2. Kingdom University Campus—Bahrain Site Map.

3.3.2. The Existing Standards

From data in Tables 1–3, some figures can be extracted as follows:

- A student's share of academic building areas excluding the circulation is calculated as per the equation of = [total built-up areas/total capacity of buildings in the academic spaces]. Thus, as shown in Table 3, a student's share of academic building areas = 2580/1362 = 1.89 m^2.
- A car's Share of OSCP built-up area is calculated as per the equation of = Total areas allocated for car parking/total parking capacity of the building. Thus, as per the figures in Table 3, a car's Share of OSCP built up-area = [12,291/279] = 44.05 m^2, including circulation and services.
- Circulation percentage in all buildings is calculated as per the equation of circulation percentage = [100 × (Total built up area-Total of Net spaces area)/Total built-up area]. Thus, as per figures in Table 3, percentage of circulation area in entire campus = [100 × (22,821 − 18,636)/22,821] = 18.1%.
- Circulation and services percentage in car parking building is calculated as per the equation of circulation and services percentage = [100 × (Car's Shear of OSCP built-up area − Net area of the car parking lot)/Car's Shear of OSCP built-up area]. Taking into consideration the net area of the car parking lot is for 90° bays as Table 2 is 14.04 m^2. Thus, the percentage of circulation and services in car parking buildings = 100 × (44.05 − 14.04)/44.05 = 68%.

A student's share in the car parking area is calculated as per the equation of a student's share is = rate of car parking lots to the number of students × Car's Share of OSCP built-up area. Taking into consideration the rate of car parking lots to the number of students is 1:5, as shown previously in Table 1. Thus, a student's share in the car parking area = 0.2 × 44.05 = 8.81 m^2.

Table 3. The capacity of spaces in existing buildings on the KU Campus.

Built-Up		Uses	Floor	Building	Number of Rooms	Area (m^2)	Capacity	User s' Shear of Area (m^2)
Net space areas	Academic	**Lecture halls**	Mezzanine	C	4	271	176 Students	1.54
			First	A, B, C	15	727	452 Students	1.61
			Second	A	2	78	52 Students	1.50
			Fourth	C	7	442	240 Students	1.84
			Total		**28**	**1518**	**920 Students**	**Average 1.65**
		Design Studios	Mezzanine	B	2	95	36 Students	2.64
			Second	B, C	10	506	180 Students	2.81
			Total		**12**	**601**	**216 Students**	**Average 2.78**
		Computer Labs	Mezzanine	C	1	57	30 Students	1.90
			Second	A, B	2	75	45 Students	1.67
			Fourth	C	1	99	39 Students	2.54
			Total		**4**	**231**	**114 Students**	**Average 2.03**
		Seminar Room	Mezzanine	A	1	132	80 Students	1.65
		Mood Court	First	C	1	98	32 Students	3.06
		Total			**46**	**2580**	**1362 Students**	**Average 1.89**
	Admin	**Staff offices**	Ground	C	4	72	5	14.40
			Mezzanine	C	5	152	7	21.71
			First	C	2	66	4	16.50
			Second	C	11	295	23	18.23
			Third	A, B	4	204	19	10.74
			Fourth	A, B	13	408	34	12.00
			Fifth	A, B	12	408	23	17.74
			Total		**51**	**1605**	**115**	**Average 13.95**
	Services	**Library**	Third	C	1	1013	170	5.096
		Cafeteria	Ground	A, C	1	585	280	2.09
		Restrooms	all	A, B, C	1	750	50	15.00
		Prayer rooms	First	C	1	114	80	1.43
		Toilets	all	All	34	580	81 WC, 112 HWB	3.00
		Sport activities	Third	E	1	1274	100	12.37
		Off-street car parking	all	E	1	12,291	279 plots	44.05
		On-streetcar parking	-	-	1		109 plots	-
		Auditorium	Fifth	C	1	950	500 persons	1.9
		Total			**42**	**18,636**	**1373**	**Average 13.57**
		Total net spaces areas			**139**	**22,821**	**1362 students**	
Total		**Total built-up areas**			**139**	**27,875**	**1362 students**	**Average 20.47**

Data sources: [33].

3.3.3. Building Envelopes

Each building on the KU campus is constructed in a different phase; therefore, the building envelope differs from one building to another. The envelope of Buildings A and B are double glazing curtain walls for the northern, eastern, and southern façades, while the western façade consists of a 20 cm thick wall's hollow bricks with plastering and panting coating, and the wall contains a few small double grass windows. The envelope of Building C is the same as the western façade of Buildings A and B but with large double glass windows. The envelope of Building D is the same as the western façade of Buildings A and B. The car parking building is not an indoor space. The envelope is constructed in parapets with 1.2 m height on all outer sides of parking floors, and this parapet is constructed with 20 cm-thick wall bricks with plastering and panting coating. Table 4 shows the calculation of the U value of the building envelope based on the thermal conductivity of the used materials. It also shows the difference between the actual U value and the required standard.

Table 4. U Value of building envelops of the exiting building in the KU campus.

Building	Elevation	Envelop Structure	Wall Layers	(C) Conductivity [1] (W/mK)	(T) Thickness(m)	Percentage	(Rl) [2] (m^2/K/W)	(Rt) [3] (m^2/K/W)	(Uv) [4] (w/m^2K)	ΔU [5] (w/m^2K)
A and B	North, East, South	Double glazing curtain walls	Glass	0.8	0.01	100	1.154	1.186	0.843	−1.257
			Airspace	0.026	0.03	100	0.013			
			Glass	0.8	0.01	100	0.019			
	West	Hollow bricks	External Plastering	0.93	0.02	90	0.462	0.555	1.800	+1.23
			Hollow Brick	0.39	0.2	90	0.015			
			Internal Plastering	1.163	0.02	90	0.001			
		Glass Windows	Glass	0.8	0.006	10	0.077			
			Airspace	0.026	0.02	10	0.001			
			Glass	0.8	0.006	10	1.154			
C	All	Hollow bricks	External Plastering	0.93	0.02	75	0.016	0.610	1.640	+1.07
			Hollow Brick	0.39	0.2	75	0.385			
			Internal Plastering	1.163	0.02	75	0.013			
		Glass Windows	Glass	0.8	0.006	25	0.002			
			Airspace	0.026	0.02	25	0.192			
			Glass	0.8	0.006	25	0.002			
D	North and South	Hollow bricks	External Plastering	0.93	0.02	100	0.022	0.552	1.813	+1.243
			Hollow Brick	0.39	0.2	100	0.513			
			Internal Plastering	1.163	0.02	100	0.017			
	East and west	Hollow bricks	External Plastering	0.93	0.02	85	0.018	0.597	1.675	+1.105
			Hollow Brick	0.39	0.2	85	0.436			
			Internal Plastering	1.163	0.02	85	0.015			
		Glass Windows	Glass	0.8	0.006	15	0.001			
			Airspace	0.026	0.02	15	0.115			
			Glass	0.8	0.006	15	0.001			
E	All	Hollow bricks	External Plastering	0.93	0.02	50	0.011	0.265	3.773	+3.203
			Hollow Brick	0.39	0.2	50	0.256			
			Internal Plastering	1.163	0.02	50	0.009			
		Opening	Nothing	0	0	50	0.000			

[1] [34,35]; [2] $Rl = \frac{T}{C}$, where Rl is the thermal resistance, T is the thickness of the wall layer, and C is the conductivity of the layer material; [3] $Rt = Rl1 + Rl2 + Rl3 + \ldots$, where Rt is the Total Resistances of all wall layers; [4] $Uv = \frac{1}{Rt}$, where Uv is the U value of the wall; [5] $\Delta U = Uv - Us$, where ΔU is the difference between the actual U value and the standard value, and Us is the standard U value according to the building regulations in Bahrain [36].

3.3.4. Illumination

All rooms on the campus have natural and artificial illuminations; however, natural light is not sufficient most of the day times except in the academic Buildings A and B in addition to the Car Parking Building E. Academic Building C lacks daylight in most of the rooms and internal lobbies and corridors due to narrow windows.

3.3.5. Ventilation and Air Condition

Academic Buildings A and B only have a central air condition system without windows for natural ventilation. All rooms in Academic Building C and Workshop Building D have windows for natural ventilation in addition to a central air condition system but natural ventilation is useless due to the hot and humid weather during most of the year days. Car Parking Building E has no air conditioning due to its design as an outdoor space.

3.3.6. Interior Finishing Materials

Floor finishing material is porcelain, wall finishes are matte paint, and suspended ceilings are made of gypsum boards for all buildings except the car parking building. Its floor finish is made of cement mortar, and its walls and ceiling are coated with coloured cement mortar.

3.3.7. Special Installations

Speed humps and wayfinding signs are fixed in the car parking building. There are no pavement platforms or car stopper curbs in this building.

4. Discussion

According to the literature and standards data analysis, the author argues that adaptation of the existing car parking building to fit other uses such as academics could be applicable in various countries during pandemics. However, challenges of adaptation slightly differ from country to country based on codes, standards, and contexts. Thus, challenges of car parking transformation design are discussed broadly, in addition, to focusing on Bahrain standards and context as an applicable case study.

4.1. Challenges of Car Parking Transformation Design

The off-street car parking is different from other buildings in many aspects such as standard dimensions, building envelope, required illumination, required ventilation and air condition, quality of interior finishing materials, and special installations.

4.1.1. Standards Dimensions

Floor height standards: According to Bahrain and Australian Design Standards, the minimum clear height of the car parking is 2200 mm for both cars and light vans [28,37]. European standards inform the minimum is 2130 mm, and the US standard is 7 ft, which is 2134 mm [38]. The clear height of the educational spaces must be between 2740 mm (9 ft) and 3650 mm (12 ft) [39]. This variation in the height of car parking and classrooms might challenge the adaptation of the car parking space into educational spaces during the pandemic period. However, the height is determined by the number of learners in the educational space, which is reduced to achieve the social distancing during pandemics. Therefore, as one of the lessons from the COVID-19 situation, the building regulations and codes related to the standard dimension of the height of educational space must be updated to include the standard dimensions of the transformed and adapted spaces.

Floor area standards: The car parking consists of parking bays with different configurations, as shown in Figure 3. Those configurations are broadly applicable overall the world countries. The car parking planners configure the bays according to the available floor dimensions without any partition wall between the parking bays, which led to no physical constraints for the adaptation of large car parking areas into smaller educational spaces, especially in the developed parking without curbs, in which the floor lining is used to determine the car and pedestrian circulations. The different configurations show that the right-angle parking is the most space saver configuration, in which 805 m^2 bay area can accommodate 24 cars with 33.5 m^2 each, including parking space, circulation roadway, and aisle passages. It required 16.6 m for the bay width.

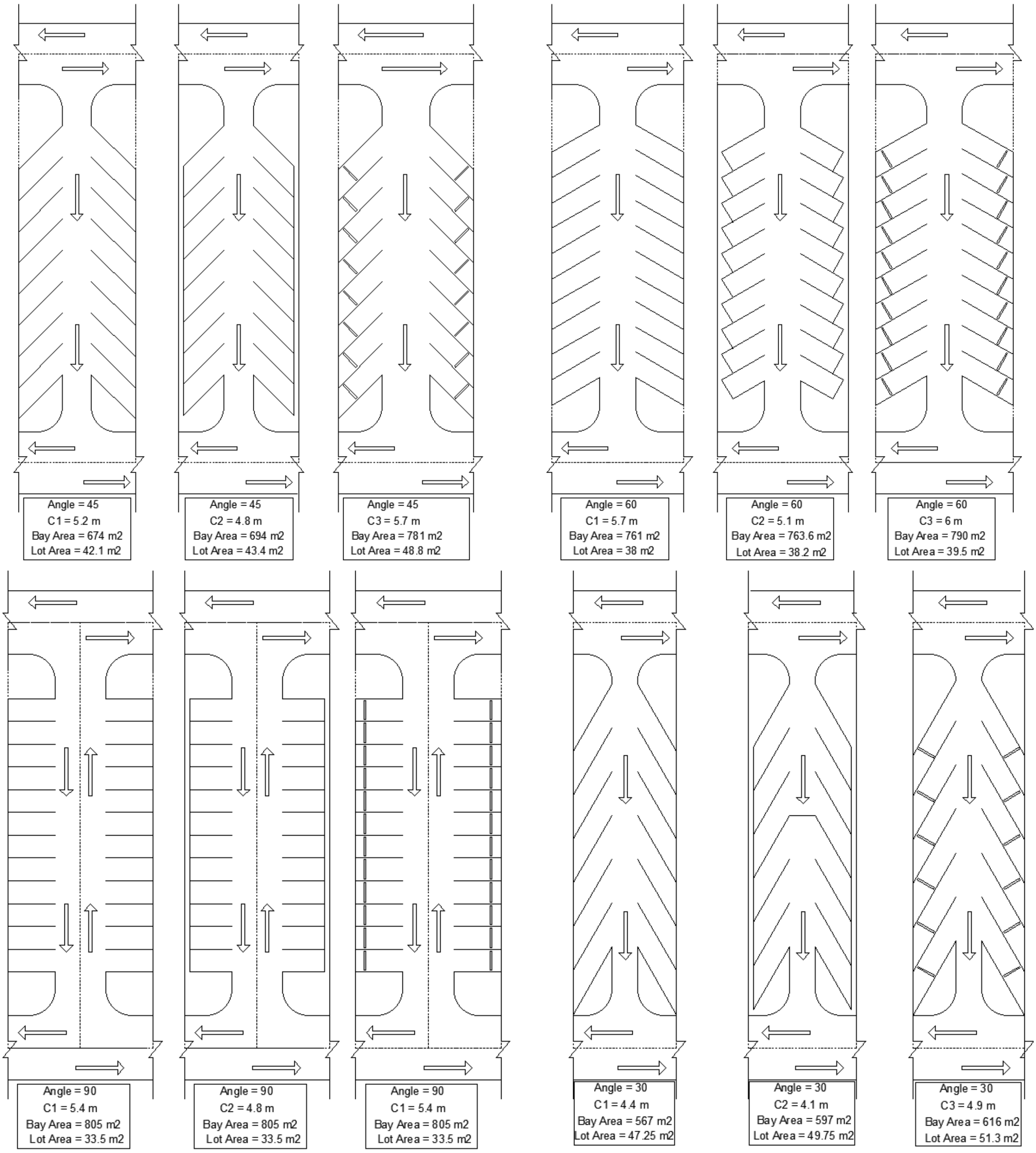


Figure 3. Car parking configuration in different angles.

The best option of car parking configuration to save area is the perpendicular on the aisle, which is indicated as an angle of 90° in Figure 4, but it needs a wide parking bay compared to the worth operation, which is the parking at 30°.

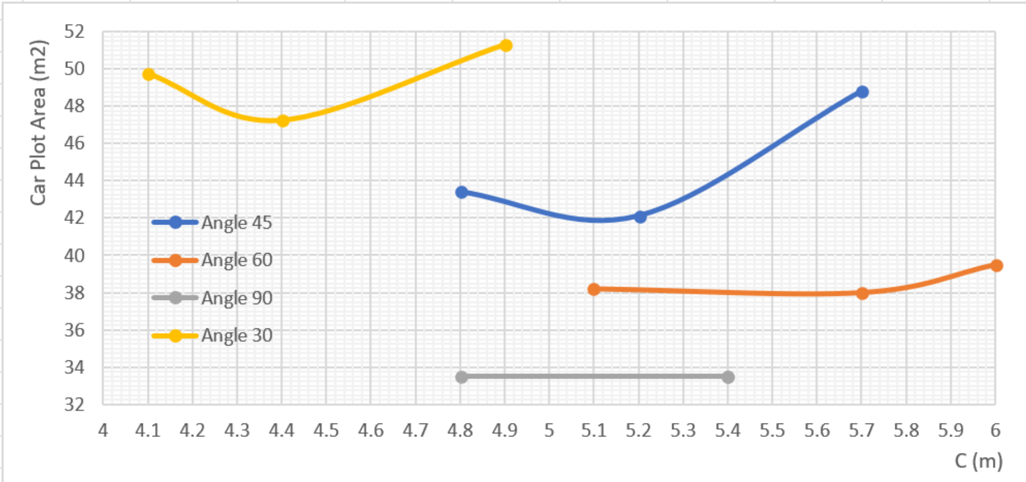


Figure 4. Chart of needed area for car parking plots according to different configurations.

4.1.2. Building Envelops

It consists of four components: foundation, walls, windows, and roof. It serves the building's functions, such as providing the rigidity of the building, supporting the structural loads, controlling heat exchange between internal and external spaces, and serving the aesthetic purpose [40]. Specifications of the building envelope varied according to the building use. Thus, the transformation design of the car parking building to educational spaces requires adaptation of the building envelope, particularly the heat exchange control according to the climate zone that the building is located in the thermal transmittance value (U Value) of walls, which ranges around the world between 0.15:0.83 W/m^2·K [41,42]. For instance, in the kingdom of Bahrain, the building envelopes of the air-conditioned buildings must perform the maximum thermal transmittance value (U Value) with 0.3 W/m^2·C for the roof, 0.57 W/m^2·C for the walls, and 1.9:2.1 W/m^2·C for the glazed surfaces [36]. Most car parking buildings have opened an envelope with part of the exterior thick parapet wall. Therefore, adapting car parking building envelope is not facing a big challenge practically in the moderate air temperature zones.

4.1.3. Illumination Standards

There is a big variance between the recommended light level in the off-street car parking buildings and the educational spaces. 50–100 lux are more than enough for car parking, while 300–500 lux are recommended for the educational spaces [43,44]. Therefore, the lighting is a vital challenge for car parking adaptation in educational spaces. The adaptation must consider providing other lighting alternatives.

4.1.4. Ventilation and Air Condition

The comfort zone is adaptable according to the geographical location, type of space in terms of indoor or outdoor, sessional changes, and behaviour of building' users [45–47]. Therefore, transforming car parking into an educational space is required HVAC services in case there are big different comfort zones between the two uses. However, in some geographical locations, the transformation process could occur without adding HVAC services, particularly in the moderate climatic zones in which natural ventilation systems could be quite enough to achieve the human thermal comfort in the hot climatic regions during the spring and winter sessions.

4.1.5. Interior Finishing Materials

Finishing materials perform a vital role in the visual and emotional identification of the interior space and protect the core structure of the walls from the external side of the façades [48]. Additionally, it is essential to coat walls, floors, and ceilings to create a suitable appearance and to protect the construction from the effects of water, heat, moisture, and abrasion.

4.2. Adapted Car Parking Building in COVID-19 Pandemic

4.2.1. Spaces Programming

One of the main precautionary measures is social distancing, e.g., (NMTC-COVID-19) The National Medical Taskforce for Combatting the Coronavirus (COVID-19) in bargain adopted COVID-19 Alert Level Traffic Light System based on the positivity rate across various sectors. It was adopting resolutions based on situations. Green, yellow, orange, and red are the four situations, and the NMTC-COVID-19 decided the maximum capacity of the educational building according to the situation level. Such capacity is a percentage of the full capacity of the learning spaces in the institute. The committee provided the HEIs with the discretion to decide on the in-person attendance of staff [49]. For instance, KU decided the same percentage that was decided by the NMTC-COVID-19 for all government entities, which are 20%, 50%, 70%, and 100% for in-person working for red, orange, yellow, and green, respectively [50]. Table 5 shows how the car parking spaces could be replanned according to the situation level.

Table 5. Spaces planning of a car parking area during different levels of the COVID situation.

	Users' Category	**Red Level**		**Orange Level**		**Yellow Level**		**Green Level**	
Max. in-person attendance	students	**0%**	**0**	30%	409	50%	681	100%	1362
	staff	**30%**	**35**	50%	58	70%	81	100%	115
	Total		**35**		466		762		1477
Required Car Parking for in-person users	For students		**0**		82		136		272
	For staff		**35**		58		81		115
	Total		**35**		139		217		387
	In on-street		**109**		109		109		109
	In off-street		**−75**		30		108		279
Unused car parking	Off-street		**354**		249		171		0
		15,554		10,946			7537		0
No of the students in converted areas		**0**		991			683		0
Total number of students			**0**	1400			1364		1362

There was an opportunity to rent the unused areas of the car parking during the red level situation, which could be an open space market area. Such an open space market was demanded by the commercial business companies as they were forced to close all malls and closed spaces markets. Additionally, the university had another option to rent this car parking building to the neighbours' maintenance and car body care services workshops. Such workshop operators could use the space for temporary car storage or car body moderations platform. During the orange and yellow level situations, the university could convert the unused car parking area into educational spaces.

4.2.2. Technical Adaptation

To implement such a proposal of reuse the car parking spaces either entirely as in red level or partially as in orange and yellow level situations, the building developer needs to adapt the building with portable acoustics partitions to divide the space, temp-floor panel for softer floor surfaces, temporary exterior partition for the building envelope with minimum U-Value 1.9 $W/m^2{\cdot}C$, additional lights hanging in the ceiling to set the illumination in minimum 50 lux in the adapted spaces for educational propose, and portable window air conditioner that could be fixed in the portable temporary exterior partition. Such an Air Condition system shall have adequate capacity for providing thermal comfort, particularly in summer, to reduce the air temperature to 25 °C at least. All such adaptations need financial resources; however, full utilization of the premises and providing a face-to-face learning environment to all students have added value and ensure high standard quality of education and accredited assessments.

5. Conclusions

The COVID-19 situation proves the significance of transformation design and flexibility of standards to ensure buildings are transformable. Transformation design, including rescheduling the space programming of existing buildings, is a powerful solution for risk mitigation of pandemics. OSCP spaces of the higher education institutes (HEIs) are the most feasible building for design transformation in terms of rescheduling the space planning. Such feasibility is a result of a high standard of car parking spaces in HEIs, in which the students' share in the car parking area is 8.81 m^2. However, the transformation of OSCP does not much achievable in terms of affordability due to lots of required adaptation and additional technical installations such as walls, floors, ventilation, insulation, and lighting. The best option for car parking configuration to save area is the perpendicular on the aisle; however, 68% of the area is used for circulation and services such as lifts, staircases, and ramps. Comparing this percentage with the average percentage of circulation spaces on all campuses, which is 18.1%.

The idea underlying the paper is to learn a lesson from the COVID-19 panoramic by testing the possibility of design transformation of campuses to address the social distancing precaution. The author argues that car parking buildings are the most suitable for implementing the adaptation strategy of building transformation. The reason is because of the high rate of the car parking area to the users who are reduced during the pandemic. The advantage of this idea is to ensure that face-to-face learning premises are provided for the in-person attendance of students while adhering to social distancing precautions. On the other hand, the disadvantage of the idea of adaptation is the demanded cost of adaptation. Therefore, the author recommends that governmental building regulators revise the building codes and standards to ensure building transformation when necessary. Additionally, the architects are recommended to start rethinking flexible design solutions for new buildings. Moreover, the author recommends a future study seeking the feasibility of smart rotary car parking to save such a huge area of car circulation in the traditional OSCP building.

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