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Digital-Based Smart Campus at Telkom University, Indonesia

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Abstract
A Smart Campus is a new educational paradigm developed in this study, and numerous changes are achieved in the sectors of technology, environment, management, education, mobility, life, security, and the university's economy. A smart campus is a way for institutions to compete in the industrial era 4.0. The smart campus system assists colleges in offering timely, accurate, and real-time services to all academicians. Previous research on smart campuses covers numerous dimensions, including the environment, education, management, mobility, people, economy, and security. The purpose of this research is to determine the components of Telkom University's digitally-based smart campus. To achieve this goal, the researcher enlisted the help of 98 Telkom University students. This research method employs a quantitative approach. A quantitative technique is used in this research strategy. The data used in this study are primary data gathered from the questionnaire responses. Confirmatory Factor Analysis was employed in this investigation, which was carried out with the assistance of the SmartPLS tool. Based on the findings of this study's analysis, it was determined that Telkom University has adopted nine components that reflect a digital-based smart campus. Among the 9 components examined, three have shown to be successful on this campus: Campus Application, Digital Presence with QR Code, and Campus Development Dashboard, while three require further improvement: Campus Academic System component, E-learning, and Job Fair System and Career Center.

Keywords: Smart Campus, Digitalization, E-Learning, ICT, Artificial Intelligence

1. Introduction

Smart initiatives continue to be developed in the digitalization era to provide convenience for humans in various components of life (E. Ahmed, Yaqoob, Gani, Imran, & Guizani, 2016; Boni, Xu, Chen, & Baddoo, 2020). To make human life easier, several applications and technologies have been developed. The Internet of Things (IoT), Information and Communication Technology (ICT), and Artificial Intelligence are examples of this (AI). Smart technologies linked to these SDGs have the potential to improve human habitation. (Boni et al., 2020; Cesconetto et al., 2020; Gubbi, Buyya, Marusic, & Palaniswami, 2013; Husain & Jain, 2020).

The term "Smart" should apply to institutions, homes, offices, communities, and universities rather than being restricted to specific product characteristics like those of telephones and computers. Given the disparities in development between the Global North and South, the process of "amortization," or "the method to be smart" (Nesti, 2020), adopts a variety of approaches in both regions. While this is going on, Smart Cities in the Global North deploy technology networks and frameworks on top of mature institutional infrastructure. Cities in the

Global South have various forms and articulations for smart city projects because of their greater public service deficits, lack of resources, vibrant informal sector, and weaker institutions. (Offenhuber, 2019; Söderström, 2020).

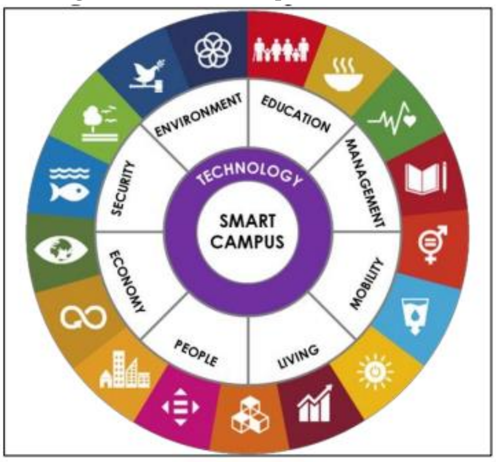
A new educational paradigm is developed on what is sometimes referred to as the "Smart Campus" in smart educational efforts. In the areas of technology, the environment, management, education, mobility, life, security, and universities, numerous advancements are achieved. economics (Ahmed, Alnaaj, & Saboor, 2020; Min-Allah & Alrashed, 2020). Telkom University is in the digitalization stage toward the smart campus category. Even though this campus uses the concept of a corporate university, it can still follow digitalization. This is because A path is a smart campus to a future institution of higher learning that should be concerned with stakeholders' demands, including students and teachers. A university is hoped to become a driving force for realizing sustainable education development as a smart campus (Clark II & Eisenberg, 2008; Coccoli, Maresca, & Stanganelli, 2017).

Shrewd campus supports all activities of the academic community during the execution of the three trees of Higher Education obligations by using information technology. The implementation is not easy because it involves many facilities that should be realized, such as smart classrooms, laboratories, buildings, departments, and faculties (Dharma Putra, 2017). The implementation needed to develop from a conventional or usual campus management situation and then switch to implementing a system using technology. A well-developed campus can implement the obligations of the three trees of Higher Education as a responsibility to science, society, and the environment.

The three pillars of higher learning have the domains of providing education, research, and community service. One of the domains that can be improved in terms of service and efficient use of technology in education. Applying technology systems in the management of the education sector will increase efficiency and stakeholder satisfaction. Making an environment and procedure conducive to learning is a deliberate and planned endeavor. Students actively cultivate their potential for morality, spirituality, self-control, personality, intelligence, and other qualities. (Wibawa, 2017).

In several universities abroad, the concept of technology on smart campuses is expected to support the learning process and further research, as well as streamline the process of delivering administrative services. Dalhousie University applies this concept to improve service satisfaction and efficiency factors. There has not been much research on smart campuses, and to Pedro (2021), a smart campus has Environment, Education, management, mobility, people, economy, and security, as shown in Figure 1.

Figure 1: Smart Campus Dimensions



The dimension that is being intensified at Telkom University and several campuses in Indonesia is the digitalization-based technology, hence, researchers are interested in researching the implementation of digital-based smart campus programs.

2. Theoretical Review

2.1. Smart Campus

Research on smart campuses has been widely carried out by experts who adopted the definition of a smart city. Based on the research conducted (Atif et al., 2014), a smart campus is an approach presented with the composition of a study room, a physical learning environment coupled with digital and social services. Meanwhile, campus facilities support all operations of the academic community in implementing the Tri Dharma of Higher Education, which leverages information technology as its backbone and is a development of conventional or ordinary campus administration, (Cordiaz, 2017).

(Iqbal et al., 2018) stated that a smart campus combines a learning system with the use of information technology, thereby facilitating the teaching and learning process and other activities. According to (Sulistyohati et al., 2018), the development of Information and Communication Technology (ICT), science, and human resources are the main supporters of smart campuses.

(Syidada & Wahyuningtyas, 2019) also stated that the Smart campus is a means for universities to win the competition in the industrial era 4.0. The system provides fast, accurate, real-time services for all academics. (Huertas Celdran et al., 2019) suggested it provides geographically dispersed online tools to access learning resources and laboratories. (Supratman et al., 2019) reported that the success of universities in utilizing Information and Communication Technology (ICT) or smart campus as a competitive and competitive effort essentially lies in several indicators such as technoware, info was, or aware, and humanware.

2.1. Smart Campus Components

Based on the research above, some components support the implementation of smart campuses. The technology and features to be owned by campuses include the following:
The research conducted (Mardiyanto & Rahayu, 2019) showed that the development of a smart campus in its application requires several components, including:

1. Provision of infrastructure- This is a basic component that functions as a smart campus service medium at a university. The services can be in the form of applications, infrastructure, and campus services.
2. Provision of basic campus services- Campus basic services provide systems or applications to the students.
3. Provision of applications and content- This is a campus service that needs to be implemented to support the convenience of students
4. Management of customer business- Business management is a development effort to achieve the goals of a campus. Good management can increase customer satisfaction.

In another research by (Supratman et al., 2019), the data were obtained using questionnaires. The results can be concluded that the development of cyber campuses is in the form of the following components:

1. ICT Use includes the dimensions of need and alignment as well as processes and governance that are not ready to be applied.
2. ICT Readiness which includes the dimensions of technology resources in the category almost successfully applied to the research.
3. ICT Capability, which includes the community dimension that has not been successfully implemented and
4. ICT Impact covers the dimensions of complaints and benefits within the near-success category.

According to (Kisworo 2020), the 6 dimensions of the smart campus consist of:

1. Smart Governance. This is a way to manage campus efficiently, and it is the most basic dimension driving others.
2. Smart Branding. Each campus should have a unique brand image as the face of the campus, and it is realized in focused governance.

3. Smart Economy. This is concerned with the ways to carry out the tri dharma in research with a simple process.
4. Smart Living. This makes the campus safe, and comfortable by paying attention to the health component or hygiene compatibility.
5. Smart Society. This is concerned with community relations on campus, both in learning and using the right technology.
6. Smart Environment. A campus should have a well-maintained environment, efficient facilities, and a comfortable green environment, using renewable energy.

According to (Hasibuan 2020), the 3 components of the smart campus consist of:

1. Infrastructure in the form of ICT devices, including smart applications, devices, and data
2. Big data includes analysis to foster a culture of appreciation
3. AI dominates s-learning

There are 10 components and variables that can be input for the implementation of digitization at Telkom University. Based on the Sevima article (Sevima 2019), there is 10 digitization conducted by universities in the disruptive era, including:

1. SPMB Online (New Student Admission System). This innovation aims to convince or attract prospective students.
2. Online Payment System. It aims to be more efficient and avoid long queues for student payments.
3. Digital Presence with QR code. Students only need to scan the QR code shared by the lecturer, and this certainly makes it easier to monitor class attendance in real time.
4. E-learning. Online learning can be a richer experience and can be conducted anywhere.
5. Campus application to monitor student dashboard and update information
6. The campus academic system aims to manage academic and non-academic systems and report student data for campus development decisions.
7. Job system and Career Center. This is important to give a fair job application and facilitate alumni employment.
8. Campus development dashboard. This intends to showcase student status and graphs depicting patterns in lecture performance and graduation projections, hence, they may assist students to organize their lectures.
9. E-certificates. This makes it simpler for students to work effectively, as certificates can be distributed by email and a QR code may be included to verify their legitimacy.
10. Online Financial System to avoid errors in manual calculations is needed for the campus.

3. Methodology

3.1. Research Design

This research uses a quantitative approach to identify the factors that support Telkom University's becoming a digital-based smart campus. There are 10 digital-based indicators derived from the Enterprise Architecture model by the Ministry of Education and Culture using the porter value chain method and the linkage of minimum standards of universities.

3.2. Population and Sample

The population consisted of the students of Telkom University. Determination of the number of samples was conducted using the Slovin formula with a significance level of 10%. Since the number of students at this university is 4,549 (PDDikti; 2021), the minimum sample number is 98 respondents using the Slovin formula.

$$n = \frac{N}{1 + (0,1)^2 N}$$

$$= \frac{4549}{1 + (0,1)^2 4549} = 97,85 \sim 98$$

Data collection was obtained from the results of distributing questionnaires, which used a Likert scale of 1-5 with a gradation of answers Strongly Disagree (STS) = 1; Disagree (TS) = 2; Doubtful (RR) =3; Agree (S) = 4 and Strongly Agree (SS) = 5. The number of indicators is 5, and they have gone through the expert validation process, with the statistical validity of the instrument test. The reliability level of the instrument is reached at the Cronbachs alpha value of 0.980, while the r count for each question item is in the range of 0.575 - 0.841. Therefore, the instrument has a high level of reliability, and all question items are valid because it has an r value < r table α=0,05; df=28 (0,361).

3.3. Data Analysis Techniques

The data were examined using a three-stage process that included (1) a descriptive analysis of the characteristics of the respondents, (2) a descriptive analysis of the research variables, and (3) a confirmatory factor analysis (CFA analysis). The SPSS program was used to perform a descriptive analysis of respondent characteristics and research variables. On the other hand, PLS analysis was carried out using SmartPLS version 3. Since there were only about 100 samples and both small and large samples were successfully analyzed by this program, it can be used for CFA analysis. (Hair et al., 2000).

4. Result and Discussion

The digital-based smart campus factor was determined at Telkom University Indonesia using CFA analysis, and FIG. 2 displays the specifications of the prototype. The stages in the CFA analysis include (1) Testing for Convergent Validity (viewed from the AVE values and the loading factor); (2) Discriminant Validity Testing (assessed from the HTMT value), (3) Construct Reliability Testing (assessed from CR and Cronbachs Alpha), (4) Goodness of fit model testing (evaluated using the SRMR, Q Square, and R square models), and (5) AVE Construct assessment which will show the most dominant factor in reflecting Telkom university's digital-based smart campus.

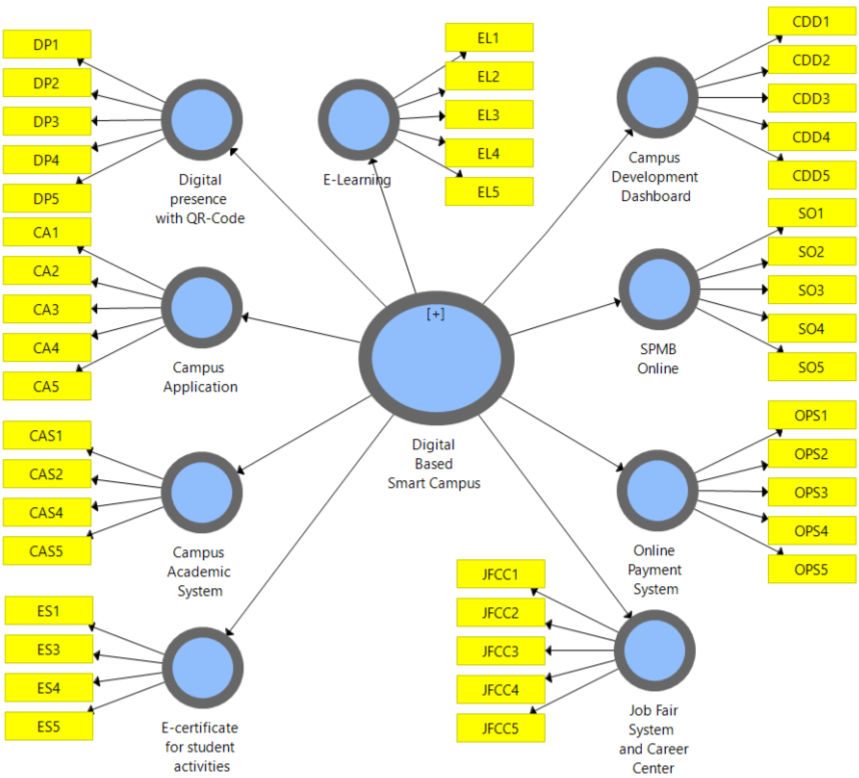


Figure 5: PLS Model Specifications

4.1. Convergent Validity

Each correlation between the indicator and the latent construct was examined using a convergent validity test. When the loading factor value is greater than 0.7 and each construct has an AVE value greater than 0.5, the indicator is deemed legitimate in this test. The results of the outer model test in Table 3 showed that several indicators are not valid in measuring the constructs [CAS3 (ʎ = 0.598) and ES2 (ʎ = 0.593)], the loading factor value is low < 0.6, while in exploratory research, the minimum loading factor limit required is 0.6. Exploratory and confirmatory and development research use a loading factor limit of 0.6 and 0.7 and 0.5, respectively (Hair et al., 2000).

Invalid indicators were removed from the SEM model, which was re-estimated to obtain an arrangement with all valid indicators in measuring each factor indicating a digital-based smart campus at Telkom University Indonesia. The display of the PLS-SEM Model with all valid indicators can be seen in Figure 3.

Besides the loading factor, convergent validity is also assessed from the AVE value. All indicators are declared to meet convergent validity when they can form an AVE construct > 0.5.

4.2. Discriminant Validity

Discriminant validity ensures that the concept of each latent model is different from other variables. In this test, the indicator is declared to meet the required discriminant validity criteria when the HTMT between constructs is below 0.9. The results in Table 4 show that the HTMT value between constructs has been below 0.9, which means that the discriminant validity was met by each construct.

4.3. Cronbach Alpha and Composite Reliability

The genuine value of a variable is measured by Composite Reliability, and the lowest reliability is measured by Cronbach Alpha. The needed Cronbach Alpha and Composite Dependability values are > 0.7 and > 0.7, respectively, for measuring construct reliability. All of the constructs in the PLS-SEM model are trustworthy, according to the results in Table 5, which also reveal that the composite reliability value is > 0.7.

4.4. PLS Model Inner Test

The calculation of the coefficient of determination, evaluation of the path coefficient, the test of the significance of the partial effect of exogenous variables on endogenous, and evaluation of the goodness of the fit of the structural model are all included in the inner model test. At this point, the hypothesis can be examined using the test results.

4.5. The goodness of Fit Model PLS

Assessment of the Goodness of fit can be assessed from the value of R and Q Squares.

1. R square. This shows the strength of the model in predicting endogenous variables. It ranges from 0-1 and is categorized into strong, moderate, and weak. According to Chin (1998), an R square value > 0.67, 0.33 – 0.67, and 0.19 – 0.33 indicate the PLS model is in a strong, moderate and weak category.
2. Q Square. The analysis's findings are shown in Table 6 show that the value of R Square Digita, attendance with QR Code (0.690), Campus Development Dashboard (0.722), Online Payment System (0.687), and Campus Application (0.725) are included in the strong category, while R square E-learning (0.555) (SPMB Online (0.588), Job Fair and Career Center System (0.551), Student Activity E-certificate (0.636) and Campus Academic System (0.454) are in the moderate category. R square modeling falls within the moderate-strong category, hence, the PLS-SEM model is considered good in reflecting the digital-based smart campus at Telkom University, Indonesia.
3. Q Square. The Q Square model's value demonstrates the degree of predictive usefulness, and it is categorized into small, medium, and large. The value of Q square 0.02 – 0.15, 0.15 – 0.35 and > 0.35 is

declared small, moderate and large. The test results in Table 6 show that the Q Square of all constructs that are indicators of a digital-based smart campus at Telkom University Indonesia is quite high and exceeds 0.35. Therefore, it can be concluded that the PLS-SEM model has great predictive relevance in reflecting a digital-based smart campus.

4.6. Inner Model Test

In the CFA analysis with SmartPLS, testing of the PLS inner model assessed the significance of each dimension in reflecting a digital-based smart campus. Furthermore, the dimensions that have not been carried out are not good in reflecting the digital-based smart campus at Telkom University Indonesia.
The estimation results with the bootstrap technique in Figure 2 show that the analyzed dimensions indicate a digital-based smart campus. This has been proven by the p-value of the inner model test on each dimension, which is <0.05, and T Statistics > 1.96. This means 9 components that reflect a digital-based smart campus have been implemented at the university. However, judging from the path coefficient variance, not all components are running well. Therefore, they should be improved in supporting the university to become a smart campus in this digitalization era.

The results showed that the 3 dimensions for the digital-based smart campus at Telkom University Indonesia are [1] Campus Applications (0.852), [2] Digital Presence with QR Code (0.831), and [3] Campus Development Dashboard. This means that the digital-based smart campus has been running very well in these three dimensions. With the application of these three dimensions, it is becoming better and attracts prospective students. Every student wants to know the latest information from their campus. Therefore, universities should prepare campus applications to monitor student dashboards and also to update news from study programs, and academic departments. Students do not miss any news with this information update, hence, they will be interested in enrolling at UIN because the campus application is excellent. One of the simple innovations is the existence of a dashboard that can display students' status, graphs showing trends in achievement, and predictions of their respective graduation. This information dashboard is very useful in helping students to plan their lecturers for the following semester. This indicates that the dashboard is a consideration for prospective students who will enroll at UIN. The better the Campus development dashboard, the higher the interest of students because Telkom University is considered to have become a smart campus that will facilitate the learning process and future careers. Currently, the average students already have a smartphone, and digitizing attendance with QR-Code is very suitable to be applied. This means students only need to take out their cellphones and scan the QR-Code. Every attendance will be logged immediately into the SIAKAD system, allowing real-time monitoring in class. Therefore, the more use of Digital Presence with QR-Code, the more students who are interested in registering on this campus. This is because digitalization makes campus administration becomes easier.

The 3 dimensions with the lowest path coefficient are [1] Campus Academic System (0.674), [2] E-learning (0.745), and [3] Job Fair and Career Center System (0.742). They are not very good at reflecting the digital-based smart campus at Telkom University because the campus has not consistently implemented these components. However, when implemented properly it will certainly be an added value for Telkom University.

The digitization of the campus academic system or SIAKAD is not less important than others in facilitating the management of academic and non-academic data. Furthermore, it assists universities in reporting academic data to the government (PDDIKTI), and also as big data for decision-making on campus development. SIAKAD has been widely used, but each campus has its form, completeness of information, and ease of use. The minimum number of errors when SIAKAD is accessed is certainly part of digitizing the UIN Syarif Hidyataullah dictionary in terms of academic administration.

Students should be familiar with E-learning to facilitate a better experience. The material in E-learning should be complete and the tasks should be presented clearly. This method is promoted on campus, but at Telkom University, there are not many lecturers who want to upload materials and learn online because face-to-face is considered more effective. Therefore, this dimension does not reflect too much on the digital-based smart campus at Telkom University Indonesia.

Application of job fairs and career centers is one measure that should be taken to guarantee that graduates obtain employment. Certainly, the online job fair method will make it simpler to locate employment. Job fairs and career centers are very important for students who are in their final semester or just graduated. There are not many job fairs organized at Telkom University, and the career center has not been expanded sufficiently.

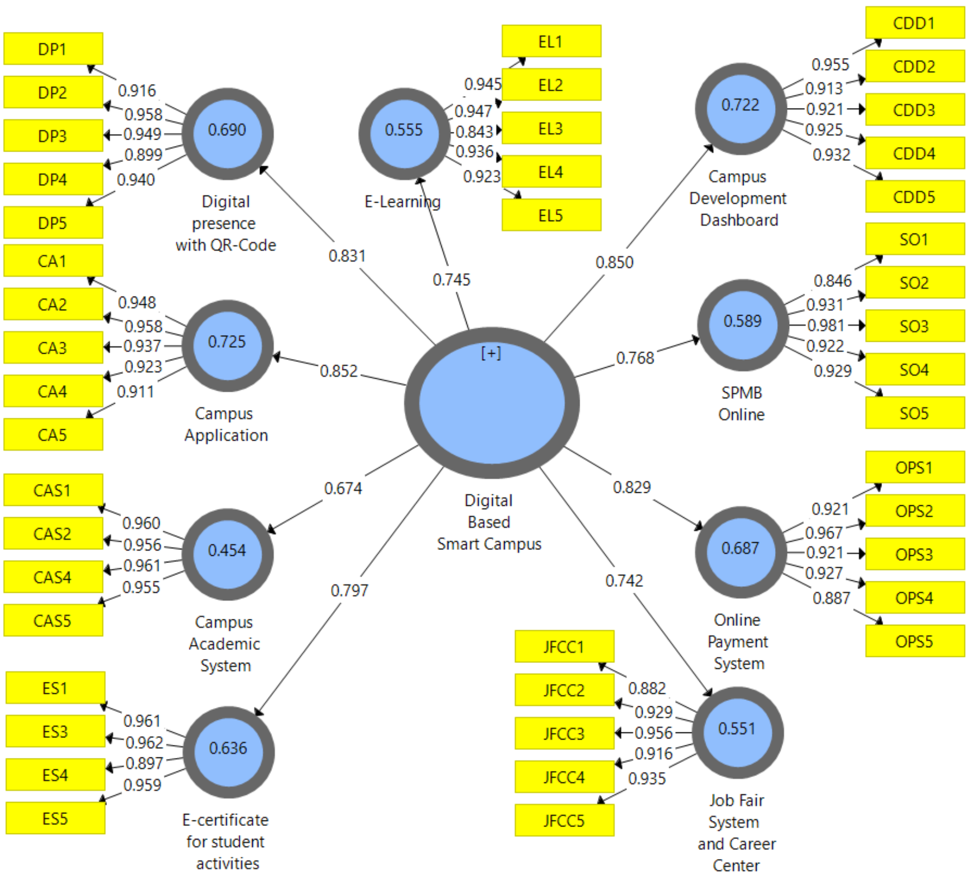


Figure 1: PLS Model Estimation Results – Algorithm

Table 1: Convergent Validity AVE and Reliability

Construct	Cronbach's Alpha	Composite Reliability	AVE
CA	0.964	0.972	0.876
CAS	0.970	0.978	0.917
CDD	0.960	0.969	0.863
DBSC	0.981	0.982	0.544
DP	0.962	0.971	0.870
EL	0.954	0.965	0.846
ES	0.960	0.971	0.894
JFCC	0.957	0.967	0.854
OPS	0.958	0.967	0.856
SO	0.956	0.966	0.851

Table 2: Discriminant Validity

Construct	CA	CAS	CDD	DBSC	DP	EL	ES	JFCC	OPS	SO
CA										
CAS	0.521									
CDD	0.697	0.487								
DBSC	0.863	0.699	0.869							
DP	0.723	0.465	0.659	0.836						

EL	0.565	0.563	0.564	0.754	0.570				
ES	0.649	0.502	0.701	0.823	0.616	0.522			
JFCC	0.685	0.479	0.665	0.825	0.634	0.500	0.637		
OPS	0.668	0.491	0.718	0.840	0.671	0.558	0.607	0.659	
SO	0.685	0.498	0.720	0.844	0.650	0.561	0.665	0.630	0.652

Table 3: The goodness of Fit Model PLS

Endogen Variable	*The goodness of the Fit Model Parameter*			
	R Square	*Adjusted R Square*	*Q Square*	*GOF Criteria*
CA	0.715	0.712	0.627	
CAS	0.446	0.439	0.398	
CDD	0.721	0.717	0.598	
DP	0.667	0.664	0.578	*Moderate – Strong Model*
EL	0.521	0.516	0.418	*Big Predictive relevance*
ES	0.647	0.643	0.545	
JFCC	0.647	0.642	0.422	
OPS	0.669	0.665	0.548	

R Square : 0.67 strong; 0.33 moderate; 0.19 weak.
Q Square : 0.02 small; 0.15 medium; 0,35 big.

Table 4: Direct Effects

Path	Path Coefficient	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (|O/STDEV|)	P Values
DBSC -> CA	0.852	0.854	0.050	17.033	0.000
DBSC -> CAS	0.674	0.669	0.093	7.263	0.000
DBSC -> CDD	0.850	0.850	0.060	14.191	0.000
DBSC -> DP	0.831	0.829	0.067	12.315	0.000
DBSC -> EL	0.745	0.741	0.092	8.088	0.000
DBSC -> ES	0.797	0.799	0.068	11.681	0.000
DBSC -> JFCC	0.742	0.753	0.086	8.659	0.000
DBSC -> OPS	0.829	0.828	0.067	12.370	0.000
DBSC -> SO	0.768	0.778	0.076	10.164	0.000

sig. level 5%, T value (two tail) = 1,96

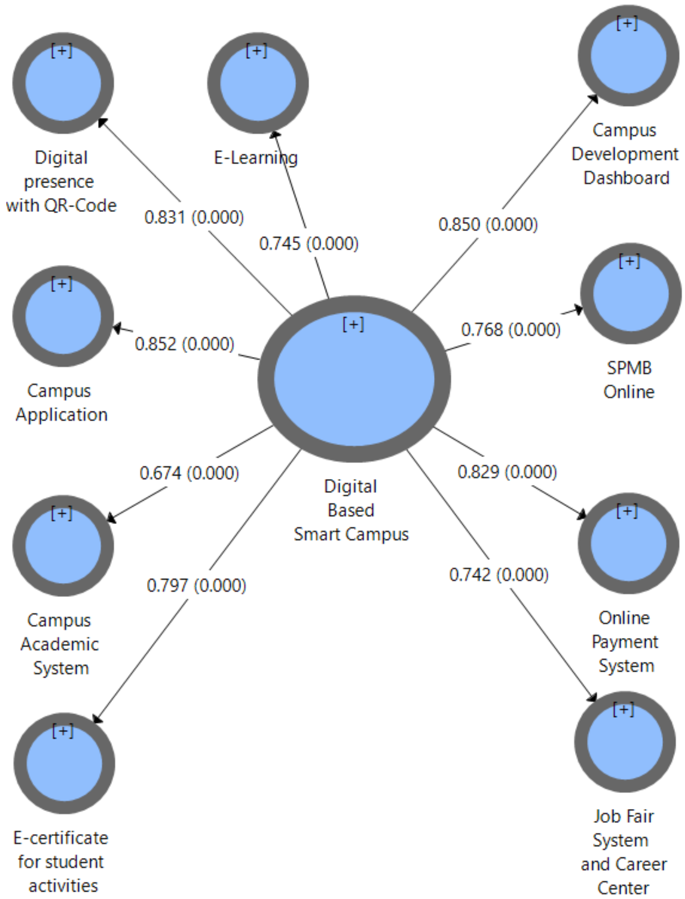


Figure 4: Bootstrapping model

5. Conclusion

The results of the analysis show that all the dimensions/components of a digital-based smart campus have been implemented at Telkom University. Judging from the path coefficient variance, some components are running well while others need improvement to support universities to become smart campuses in this digitalization era.

Based on the results, the 3 dimensions/components that best reflect the digital-based smart campus at Telkom University are the Campus Application, Digital Presence with QR Code, and Campus Development Dashboard. Therefore, the digital-based smart campus has been running very well in these three dimensions. With the application of these dimensions, the digital-based smart campus is becoming better and attracting prospective students.

The 3 dimensions/components that cannot reflect the digital-based smart campus are the Campus Academic System component, E-learning, and Job Fair and Career Center System. The three dimensions are not very good in reflecting the digital-based smart campus because they have not been consistently implemented. However, when correctly executed, it will undoubtedly offer value to Telkom University.

6. Suggestion

The dimensions/components that have not been able to reflect the digital-based smart campus at Telkom University are the Campus Academic System, E-learning, and Job Fair and Career Center System. This is because those three have not run well and are not consistently implemented by the campus, even though proper implementation will certainly be an added value for Telkom University. Therefore, it is suggested that Telkom University should optimize the Campus Academic System, E-learning, as well as the Job Fair and Career Center Systems that have been running to support the learning process and the careers of graduates. Further research should also be conducted by taking smart campus components such as economic and education listed in the Smart Campus Frame Work by Pedro (2021).

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