Risk Management Analysis Of Public Street Lighting (SMART PJU) As Quick Win Smart Environment Of Semarang City

Singgih Manggalou[1*], Binti Azizatun Nafi'ah[2], Yulinda Uang[3]

[1,2] Department of Public Administration (UPN "Veteran" Jawa Timur), Indonesia
[3] Universitas Halmahera, Indonesia
*Corresponding Author:
Email : singgih.m.adneg@upnjatim.ac.id

Abstract.

The purpose of program design is to ensure the successful implementation of a program. However, many programs are currently failing to be executed due to a failure of measures to prevent the occurrence of failure factors. The planning of diverse smart city programs has a high potential for failure, especially in today's era of digital government. The deployment of analytics-based SMART PJU in Semarang City, for example, necessitates extensive and meticulous planning. The program requires not only management planning but also risk management. This study intends to assess the map of potential risks in the Semarang City SMART PJU of IoT program, as well as how the program's risk management works. This study is based on qualitative data collected through primary and secondary sources. Primary data is collected by purposefully interviewing related informants, and the data is subsequently evaluated using qualitative methods. According to the conclusions of this study, the largest level of risk occurs due to less maintenance human resources. Semarang City also does not yet have human resources for data analytics experts and AI experts so it will be difficult to operate SMART PJU analytics. Risk mitigation that is currently needed is to conduct socialization and selection of analytic human resources. The other high risks are related to technical matters, namely the hardware used is still manual, using a timer; stolen panels; and panel broken. smart city development in Semarang City is still at the smart city 2.0 stage.

Keywords: *Smart City; Internet of Things s; SMART PJU analytics; and Risk Management.*

I. INTRODUCTION

All government programs are dangerous, varying in complexity (Project Management Institute, 2017). These dangers are the reasons why government programs may fail to be implemented. Simultaneously, government initiatives respond to stakeholder expectations, which might be competing and shifting. To deliver value while balancing risks and rewards, organizations must choose to bear program risks in a managed and purposeful manner (Project Management Institute, 2017).The notion of risk includes both unpredictable events that can harm the program (threats) and those that can help the program (opportunities) (Project Management Institute, 2017). The presence of high uncertainty due to the novelty involved in this sort of program, for example, carries considerable risk in the Semarang City SMART PJU Internet of Things (IoT) program, resulting in many failures (Simonofski, et al., 2019). Several potential risks can be identified in this type of program, including the level of stakeholder involvement in the program; disruption of information flow and communication between stakeholders; strategic misalignment; lack of program socialization, and many others (Fernandes et al., 2021). An in-depth investigation is required to analyze the risk management of SMART PJUs Internet of Things(IoT) program.According to the literature, risk management is becoming increasingly important in the public sector because it can provide a systematic process for identifying and managing risks, assist in achieving various program objectives, improve program monitoring, improve communication between program stakeholders, facilitate decision making, process and prioritize actions, and ultimately increase the chances of program success(Cedergren et al., 2022; Cienfuegos Spikin, 2013).

According to Putri's research (2021) on toll road development risk analysis, funding risks, poverty risks, and environmental, social, and political risks are all concerns linked with toll road building.Risk management is a continuous process that is directly dependent on changes in the internal and external environment, necessitating constant attention to the identification and control of program risks (Oduoza, 2020). Risks, if left uncontrolled, have the ability to depart from the plan and lead the program to fall short of its objectives. As a result, program risk management efficiency is linked to project success (Alam & Ray-

Bennett, 2021; Rivera et al., 2020).In a nutshell, the goal of risk management is to create methods that limit the negative impact of risks while increasing the positive impact of risks on program objectives. It handles risks based on program exposures, increases budgeted activities and resources, and adjusts the program timeline(Project Management Institute, 2017). As a result, doing a risk analysis of the SMART PJU Internet of Things (IoT) program can help to mitigate the negative impact that will occur later.The Semarang municipal communication and informatics service program is a public program owned by most local governments, emphasizing the necessity of risk management in the SMART PJU Internet of Things (IoT) initiative. The entire community requires the SMART PJU Internet of Things (IoT) initiative. The ease of service and comfort of the community are absolute in today's digital era. On the other hand, smart city development is accelerating (Bellini et al., 2022).

Smart City-based city or regional development movements can be seen in cities throughout the world, including Barcelona, Tokyo, London, Berlin, Amsterdam, Melbourne, Seoul, Shanghai, Mumbai, Singapore, and others. Every city in different regions of the world has a different Smart City development success story based on the difficulties that each city faces (Fernandes et al., 2021). In Korea, a 600-hectare reclamation area was developed from the ground up as a Smart City, whereas in Dubai, Masdar is a city that is determined to become a carbon-free city by developing energy independence programs with solar and renewable energy. Amsterdam focuses on developing Smart People, Smart Energy, and Smart Waste Management. In Singapore, Smart City development is overseen directly by the Prime Minister's Office as a program for residents, businesses, and government to improve quality of life via the use of technology, ideas, applications, and big data. Technology may aid in the formation, management, and use of businesses (Zainal et al., 2021).Semarang City has an Internet of Things (IoT) SMART PJU program as a smart city quick win in the area of Smart Society. This program is the flagship program of Semarang City because it prioritizes technology in the implementation of monitoring community activities through analytic-based SMART PJU. However, no risk analysis has been conducted by this program. So the author conducts research aimed at assessing the risks posed in this program and conducting risk mitigation analysis so that the implementation of the program can run successfully.

Smart City

According to research in the subject of digital governance, the era of digital governance has penetrated the public sector since 2000 (Alcaide-Muñoz et al., 2017). The rapid advancement of digital governance research parallels the quick advancement of smart city deployment in numerous places throughout the world (Wawer et al., 2022). Even today, with the construction of smart cities, Artificial Intelligence is employed to make public policy decisions (Bokhari & Myeong, 2022).There are two approaches to the smart city concept that are often mentioned in the literature, namely smart cities that focus on ICT development and smart cities which focus more on the participation of local communities in building sustainable cities (Cortés-Cediel et al., 2021; Simonofski, et al., 2019). However, the smart city literature focuses on how technology solves societal problems more than any other focus (Thomas et al., 2016).IoT risk management SMART PJU Semarang City is required to foresee the most extreme risks that may emerge to interrupt implementation or possibly become a factor in program failure (Caragliu et al., 2011). According to Purnomo, smart city characteristics are classified into six categories: smart economy, smart environment, smart government, smart living, smart mobility, and smart people (Purnomo, 2016).

Table 1. The three generations of smart cities

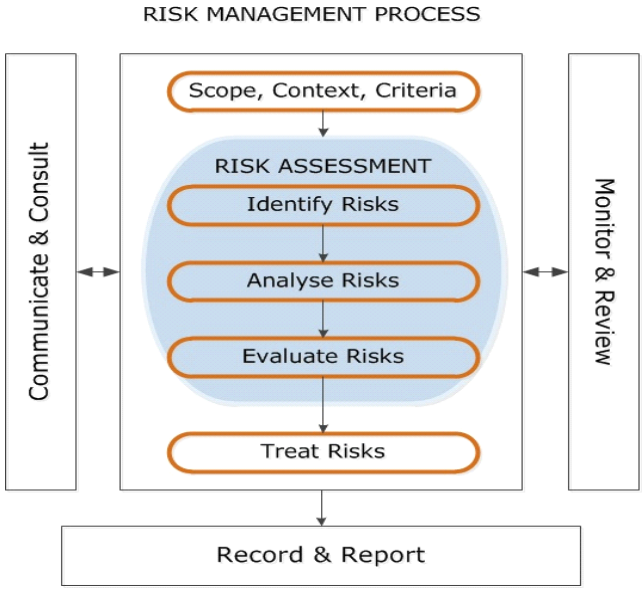
Smart City 1.0	Smart City 2.0	Smart City 3.0
Creators of technical developments encourage cities to apply their solutions in order to improve the efficiency of urban management.Technology is a critical component of the smart city-1.0 idea.Technological improvements are frequently applied in cities that are not fully equipped for this process.	Local governments are crucial in the development of smart cities 2.0. They concentrate on new technology in order to investigate numerous solutions for improving the quality of life in cities.Cities conduct initiatives and projects that encourage the use of modern technologies in a variety of settings. The importance of quality of life and local government is linked with that of modern technology in a smart city 2.0.	This is the most recent and advanced generation of smart cities. Citizens play a critical role in urban development. Local citizens voluntarily opt to participate in the process of constructing contemporary cities; they are inventive and rely on modern social participation tools. Urban space is built for people and with their participation in smart city 3.0.

Source: (Szarek-Iwaniuk & Senetra, 2020)

In Indonesia, smart city research is mostly concerned with ICT development. The Ministry of Communication and Informatics promotes the program of 100 smart city cities/regencies by focusing on ICT projects that can help resolve community problems in public services and local government management. For example, the Semarang City Government created an innovative Internet of Things (IoT) SMART PJU program to solve the issue of monitoring community activities through the use of ICT in the form of analytics-based SMART PJU. The introduction of this program provides a safe and comfortable sense of community in carrying out daily duties since they are protected by 24-hour surveillance.

Risk Management in program government

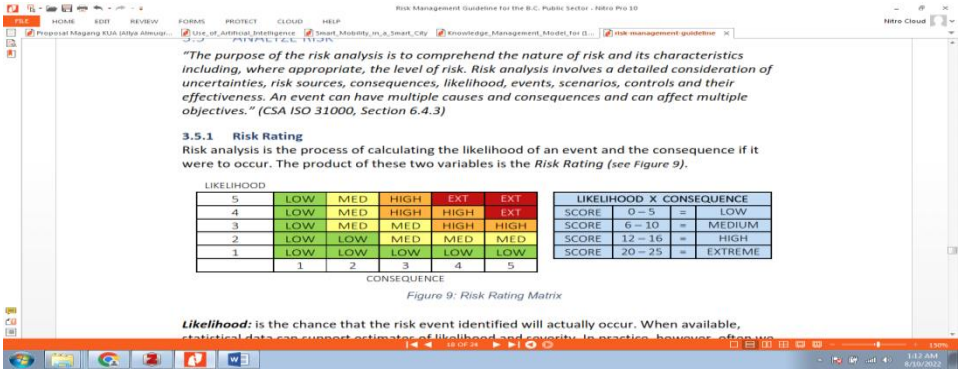
Risk management is a systematic attempt to understand and manage risk, minimize uncertainty, and make it simpler to achieve goals and objectives. (Ministry of Finance, 2019). The influence of uncertainty on goals is referred to as risk. The international standard CSA ISO 31000 is used to describe risk management in the government or public sector. Using this standard, public sector risk management entails identifying risks, adopting risk mitigation techniques, establishing priorities, facilitating discussion about the types and degrees of risk that the government is willing to take (tolerance), and developing long-term plans for the future.In the public sector, risk management must be linked with business processes. This indicates that risk information can have an impact on policymaking. The following is the risk management procedure in the public sector.



Source: (Ministry of Finance, 2019)

Fig 1. Risk Management Process

The first step is to know the scope, context, and risk criteria in a public sector. In this study, to find out the scope of the IoT SMART PJU, such as service profiles. The context of the risks that may occur and the limitation of risk criteria that will occur.The next step is to identify what risks might occur. Then analyze the risk by providing a risk rating. Risk analysis is the process of calculating the likelihood of an event and the consequences if it occurs. The product of these two variables is the Risk Rating (see Figure 2).



"The purpose of the risk analysis is to comprehend the nature of risk and its characteristics including, where appropriate, the level of risk. Risk analysis involves a detailed consideration of uncertainties, risk sources, consequences, likelihood, events, scenarios, controls and their effectiveness. An event can have multiple causes and consequences and can affect multiple objectives." (CSA ISO 31000, Section 6.4.3)

3.5.1 Risk Rating

Risk analysis is the process of calculating the likelihood of an event and the consequence if it were to occur. The product of these two variables is the *Risk Rating (see Figure 9).*

LIKELIHOOD					
5	LOW	MED	HIGH	EXT	EXT
4	LOW	MED	HIGH	HIGH	EXT
3	LOW	MED	MED	HIGH	HIGH
2	LOW	LOW	MED	MED	MED
1	LOW	LOW	LOW	LOW	LOW
	1	2	3	4	5

CONSEQUENCE

LIKELIHOOD X CONSEQUENCE			
SCORE	0 – 5	=	LOW
SCORE	6 – 10	=	MEDIUM
SCORE	12 – 16	=	HIGH
SCORE	20 – 25	=	EXTREME

Figure 9: Risk Rating Matrix

Likelihood: is the chance that the risk event identified will actually occur. When available,

Fig 2. Risk Rating Matrix

Types of risk include internal, external, strategic, and major projects (Manzoni & Cheshire, 2017). Risks that originate internally are risks that come from within the organization and can be controlled. Risks that come from external sources are risks that come from outside the organization that are difficult to control but can minimize the impact that occurs. Risks originating from strategy are related to goals, objectives, programs. Monitoring and program adjustments are continuously carried out so that risks can be minimized so that organizational goals can be achieved. The fourth risk comes from major projects such as engineering, reporting processes and so on.The likelihood is the probability that the identified risk event will occur. Statistical data, when accessible, can help support estimations of likelihood and severity. In practice, however, we frequently lack historical data. Instead, we frequently rely on the collective experience of those present; hence, likelihood rarely indicates mathematical certainty; rather, it is a subjective judgment.

Table 2. Risk Criteria

Likelihood = Probability of the risk event actually occuring		
Score	**Criteria**	**Probability (%)**
5	Almost certain	80%-99% or once a day or more frequently
4	Likely	61%-79% or once a week
3	Possible	40%-60% or once a month
2	Unlikely	11%-39% or once six months
1	Almost certain not to happen	0%-10% or once a year

Source: (Cienfuegos Spikin, 2013)

Consequence = Degree of severity, with respect to goals/values, should the risk event occur		
5	Catastrophic	Major problem from which there is no recovery Significant damage to ministry credibility or integrity Complete loss of ability to deliver a critical program
4	Major	Event that requires a major realignment of how service is delivered Significant event which has a long recovery period Failure to deliver a major political commitment
3	Moderate	Recovery from the event requires cooperation across departments May generate media attention
2	Minor	Can be dealt with at a department level but requires executive notification Delay in funding or change in funding criteria Stakeholder or client would take note
1	Insignificant	Can be dealt with internally at the branch level No escalation of the issue required No media attention No or manageable stakeholder or client interest

Source: (Cienfuegos Spikin, 2013)

Following the publication of the risk rating, the risk is evaluated and risk mitigation is provided.

II. METHODS

The primary goal of this study is to examine and develop the best risk management program for the Internet of Things (IoT) SMART PJU program. As a result, this study is classified as qualitative. The researcher used interview guides to conduct in-depth interviews with four informants: communication and information technology personnel, transportation staff, and Semarang regional development planning agency staff. The purposeful selection of informants is due to the selected employees who have the key roles, expertise, and abilities in the Smart PJU (Creswell & Poth, 2018). Researchers filter and select the results of in-depth interviews, which are subsequently processed and evaluated using qualitative analytic methodologies (Sugiyono, 2016).The stages of this research include gathering both primary and secondary risk data, as well as categorizing the data based on nature, structure, infrastructure, superstructure, and culture. The environment is one of nature's elements. Community HR, HR bureaucracy, and regional finance are all structure elements. Infrastructure components include physical, digital, and technological factors.

Law, politics, and institutions are examples of superstructure aspects. Social and economic factors are cultural elements. The second assesses risk using the Risk Rating Matrix. Third, compute the potential value and score value, and then multiply the two results. Furthermore, after the overall risk value score is known, the researcher categorizes the danger into risk tiers.

III. RESULTS AND DISCUSSION

Government programs and projects have innovation challenges as a result of digital transformation (Peixoto et al., 2014). In this context, dynamic environmental changes lead to a wide range of risks. The government must have comprehensive knowledge to handle risks. Risk management aims to minimize the probability and threat of risks and then capture opportunities that arise during the program life cycle (Alhawari et al., 2012).Smart Ligthing System is a system that was developed to help the community to report reporting from the community if there are PJUs that go out, and monitoring the points of PJUs that go out, points that go out. Currently, Smart PJUs in Semarang City amount to 3,774 points or around 6.27% of the total PJUs in Semarang City. 6.27% of the total PJUs in Semarang City. And it will continue to be developed.The uniqueness of this program is the utilization of SMART PJU for the Internet of Things. The public can download the SALJU application (Sistem Aplikasi Lapor PJU) on Playstore. This app is for reporting application, application for PJU, and application for communal WWTP. Through the application, the public can report PJU complaints, as Satriyono Sujoko did.

The client reported PJU repairs, responded and worked on within 3 days. In addition, the community can also apply for PJU lamp assistance. Not only public street lights, but can also apply for communal IPAL and residential fiber receiving areas.The SALJU application provides report tracking information. The community will understand how far the report has been made. The location of dead street lights can be known quickly through community updates. PJU officers will immediately attend the location point according to the point maps sent by the community through the application. This information is very helpful for operators at work. PJU operators benefit from efficiency and effectiveness in work, especially in handling PJU problems.The benefits of this application are to provide faster, easier and cheaper information related to PJU points on the main roads that go out. Another benefit is to speed up the handling of PJU damage and save handling costs because the damaged point is immediately known and provides efficiency in the use of electric power.The challenge in the development of this application is that if there is a system failure, the consequences will be very high. The local government has stated the regional innovation program in the RKPD and has been implemented in the last 2 years. Implementation and determined by Decree of the Regional Head. However, the need for human resources is not sufficient, along with the number of public complaints related to PJU.

Table 3. Risk Management of SMART PJU in Semarang City

RISK IDENTIFICATION					RISK ANALYSIS			RISK TREATMENT			RISK MITIGATION	
	Category	Sub category	Risk	Consequence	Possible Value	Score impact	Risk Value	PIC	Target Time / Frequency	Resource Needs	Structural	Non Structural
1	2	3	4	5	6	7	8	9	10	11	12	13
1	**Nature**	Environment	Flood	road and public prosecutor's pole flooded	3	1	3	Public works office	As soon as possible	drains and blockages	periodic checking and cleaning of channel cleanliness and discharge	Water channel check, river check, DAM check, water pump check
			landslide	interrupted SMART PJU connection line	1	**3**	3	public works department	1 year	Budget for construction of soil barriers and greening	Construction of cast barriers, tree planting	
			weather changes	road and public prosecutor's pole flooded	1	3	3	public works department				
2	**Structure**	Bureaucratic HR	Less maintenance human resources	Maintenance human resources are too tired, overworked	5	**4**	**20**	Communication and informatics office; Personnel education and training agency	6-12 months	limited number of human resources for maintenance and tools	turn taking and prioritization for improvement	recruitment of new personnel and training by BKPP
			No human resources for data analytics and AI experts	Lack of maximum data analysis and utilization	3	4	12	Communication and informatics office; Personnel education and training agency	6-12 months	Budget to recruit and pay human resources, increase the quality and quantity of human resources	Open Data Analytics formation	Socialization, selection, training
3	**Infrastructure/Application**	Technology	broken solar panel	dark and unsafe streets; panel cannot function properly because it is damage	4	**4**	**16**	Semarang City Housing and Settlement Area Agency	all year round	panel unit changeover	panel repair	panel repair and unit replacement

			Hardware cannot be automated (still using a timer)	need many manual timers	**4**	**3**	**12**	Semarang City Housing and Settlement Area Agency	1 year	Budget for SMART PJU Analytic procurement	Procurement of goods in the form of SMART PJU with analytic technology	
		Digital infrastructure	server is still abroad	**prone to being hacked**	3	**4**	**12**	Semarang City Housing and Settlement Area Agency	1 month	server	server procurement	server procurement dan recruitment server operator
4	**Superstructure**	Law	Stakeholder leaders are not yet committed to SMART PJU integration	Some blank spots are not monitored by SMART PJU analytics	3	3	9	Communication and informatics office, OPD and other external stakeholders	1 year		Socialization and negotiation of SMART PJU integration from OPDs and external stakeholders	Acceleration of integration with the signing of the MoU agreement
5	**Culture**	Social	panels stolen	panel does not work because it is missing. dark and unsafe streets	3	**2**	6	Semarang City Housing and Settlement Area Agency	Around year	Cctv	cctv installation, replacing another panel	cctv installation and integrated cctv

Resources: Data primer, 2023

The Risk Level measurement is calculated as the Risk Level multiplied by the Probability Level multiplied by the Impact Level. The risk analysis of the Semarang City SMART PJU IoT program in Table 4 shows a very high risk in the restricted number of operators who monitor analytical SMART PJU. While the chance of damaged/lost devices is negligible. The following matrix displays the value of high to low risk.

Table 4. Risk Level Matrix of SMART PJU IoT Program

		Likehood				
		1	**2**	**3**	**4**	**5**
Consequence	1	**Low**	**Low**	**Low** landslide	**Low**	**Low**
	2	**Low**	**Low**	**Medium** Panel stolen	**Medium**	**Medium**
	3	**Low** Flood Weather changes	**Medium**	**Medium** Stakeholder leaders are not yet commited to Smart PJU integration	**High** Hardware cannot be automated (still using a timer)	**High**
	4	**Low**	**Medium**	**High** • No human resources for data analytics and AIexperts • Server is still abroad	**High** broken solar panel	**Extreme** Less maintenance human resources
	5	**Low**	**Medium**	**High**	**Extreme**	**Extreme**

Source: Primary data, 2023

So, after learning about the Smart society risk level matrix, risk mitigation is required. Risk mitigation is a deliberate and long-term action done by the risk owner to mitigate the consequences of an incident that has the potential to harm or threaten the risk owner. There are numerous risk mitigations in smart city programs, including the Quick Win Smart PJU for Semarang City.

Table 5. Risk Mitigation Matrix of Smart PJU

ID	**Risiko**	**Mitigasi Struktural**	**Mitigasi Non Struktural**
1	2	3	4
R-1	Less maintenance human resources	turn taking and prioritization for improvement	recruitment of new personnel and training by BKPP
R-2	No human resources for data analytics and AI experts	Open Data Analytics formation	Socialization, selection, training
	Server is still abroad	server procurement	server procurement dan recruitment server operator
	Hardware cannot be automated (still using a timer)	Procurement of goods in the form of SMART PJU with analytic technology	
	Broken solar panel	panel repair	panel repair and unit replacement
R-3	Stakeholder leaders are not yet commited to Smart PJU integration	Socialization and negotiation of SMART PJU integration from OPDs and external stakeholders	Acceleration of integration with the signing of the MoU agreement
	Panel Stolen	cctv installation, replacing another panel	cctv installation and integrated cctv
R-4	Landslide	Construction of cast barriers, tree planting	Water channel check, river check, DAM check, water pump check
	Flood	periodic checking and cleaning of channel cleanliness and discharge	
	Weather changes	procure PJU equipment that can withstand extreme weather changes	cooperate with BMKG

Source: Primary data, 2022

The most extreme risk in the Smart PJU is less maintenance human resources. PJU requires periodic maintenance every month. Semarang City only has ten technicians to maintain all PJU points. On the other hand, submission through SALJU is just a matter of typing. if it is not completed within three days, the report will become red or bad. netizens began to criticize the local government for not being able to handle PJU complaints. This is quite troublesome for officers. So it is necessary to add PJU maintenance technician officers so that if there is a PJU damage report at several points simultaneously it can still be handled according to the standard. Another high risk is that the Semarang city government still rents an overseas server to accommodate SALJU application data. local governments still rent other providers' servers to meet

data storage needs. This is very worrying where the server is an important part of storing personal data. an agency should have its own server for its agency data. it is necessary to procure a server and manage it yourself. servers that are still renting have the opportunity to be hacked.

The hardware used is still manual, using a timer. Smart PJU should have high technology where lights turn on/off using sensors. This has not been implemented in the PJU of Semarang City Government. It is necessary to procure PJUs that use automatic sensors to turn on street lights.The socio-culture of the surrounding community also still affects the implementation of smart PJU. There are many cases of PJU and bridge frames being stolen. This also happened in Semarang City. Many solar panels are missing. Box panels are stolen for resale. thefts are usually carried out in the middle of the night at light points that are far from settlements. there is no street cctv that can record the theft. the security forces have difficulty tracking the theft of solar panels. then the mitigation that really needs to be done is to install cctv.Minor risks that rarely occur in the smart PJU program are landslides at PJU points, PJU poles are flooded so that they easily shake or collapse, and extreme weather changes cause PJU to be damaged. This risk is rare but when it occurs it causes massive damage. To avoid it, it is necessary to coordinate with the meteorological agency to update the weather and the possibility of disaster. The quality of PJU also needs to be improved so that when there is a minor disaster it is not immediately damaged.

IV. CONCLUSIONS

IoT risk management SMART PJU Semarang City is required to foresee the most extreme risks that may emerge to interrupt implementation or possibly become a factor in program failure. Based on the findings, the most extreme risk is less maintenance human resources. On the other hand, Semarang City also does not yet have human resources for data analytics experts and AI experts so it will be difficult to operate SMART PJU analytics. Risk mitigation that is currently needed is to conduct socialization and selection of analytic human resources. The other high risks are related to technical matters, namely the hardware used is still manual, using a timer; stolen panels; and panel broken. These technical matters can hinder the Smart PJU, so strengthen the anticipation of technical matters by use automatic sensors and installed cctv. Minor risk are landslides at PJU points, PJU poles are flooded so that they easily shake or collapse, and extreme weather changes. When viewed based on the most extreme risk, smart city development in Semarang City is still at the smart city 2.0 stage.

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