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A Causal Loop Diagram of Banyumas Tourism Projection with Transportation System Improvement

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Abstract: Banyumas is one of the famous tourist destinations in Central Java with its natural attractions. Tourism growth in Banyumas requires capable and sustainable transportation infrastructure. However, current policies and investments in Banyumas are inappropriate for developing transportation and tourism infrastructure that creates non-significant impact. Therefore, the development of tourism projection should consider environmental, social, economics, and technology interrelated in developing transportation and tourism infrastructure issues. The tourism supply chain has a unique structure that is different from typical supply chains with high complexity because many stakeholders are involved. This research aims to project Banyumas tourism development with the impact of transportation system improvement. This conceptual model was developed from literature reviews and other necessary sources, and then validated by experts. The conceptual model examines the relationship between variables involved in the tourism supply chain and transportation system in Banyumas that can be developed into a quantitative model using Causal Loop Diagram, an initial stage of system dynamics. This model used to analyze the behavior of visitor projection of the Banyumas tourism supply chain system in Indonesia.

Keywords: Tourism supply chain, transportation system, model formulation, Causal Loop Diagram.

Introduction

Tourism is a sector that has great potential to generate foreign exchange and can be a source of economic drivers for a region. The development of Central Java tourism has increased from year to year until, in 2020, the number of tourist attractions, special interests and others reached 956 tourist locations, with the number of tourists increasing before COVID-19 in 2019 there were 54.9 million people [1]. In line with the post-COVID-19 economic recovery plan and the tourism and creative industry developed plan until 2025, increasing tourism growth must be increasingly supported in Blueprint for The Development of Indonesia's Creative Economy 2025 [2]. Banyumas Regency in Central Java is one of the areas that have abundant and diverse natural potential, so it has great potential in the tourism sector with 45 natural tourist attractions, two cultural tourist attractions, seven artificial tourist attractions, and other tourist attractions with total tourist attraction is 95 tours. These numbers have slightly dropped during COVID-19 and need improvement after the recovery plan [1].

Tourism development has always been one of the government's priorities to be optimised because of its contribution to the Gross Domestic Product, which impacts foreign exchange earnings from foreign tourist visits. The tourism industry can also provide jobs and reduce unemployment. Currently, 9% of the total national workforce is estimated to work in the tourism sector. Tourism has contributed around 5% to the Indonesian economy [2]. According to the Ministry of Tourism and Creative Economy, several efforts are being made to increase tourism development: (1) potential development of tourism destinations; (2) potential for tourism marketing development; (3) potential for tourism industry development; (4) potential for tourism institutional development [3].

One of the potentials for tourism development is realised by developing infrastructure and network connectivity between regions and destinations. Transportation infrastructure is the basis for the successful creation /

establishment of new tourist locations in line with the development of transportation infrastructure in the surrounding area [4]. With the availability of good transportation facilities, tourists will be more interested in visiting because of the easy access to connectivity offered, especially tourists from other areas. Recent empirical studies show that tourist destinations with good infrastructure and transportation systems will attract more tourists [5], [6]. The transportation facilities needed include road conditions, traffic signs, and the connectivity provided.

Banyumas Regency is still far from a good transportation system with road access and well-functioning traffic signs, even though it has a free public transportation facility (Trans Banyumas) and other public transportation. The district has a train station with many train departures to and from various cities on the island of Java. Banyumas Regency is close to General Sudirman Airport in Purbalingga to access Banyumas Regency from outside Java or by plane. Unfortunately, these train stations and airport facilities are not supported by integrated transportation access from train stations and airports to tourist destinations such as Baturaden and other destinations. Tourists need to use separate public transport, which is quite far away from the train station and airport, or use private transportation. The current condition of Banyumas's transportation system needs to be improved.

Improvements to Banyumas Regency's transportation system might include improving access connectivity to Banyumas' main tourist location, the Baturaden tourist area, and other tourist attractions. One way is to implement a macro transportation pattern policy with a mass public transportation design integrated with the Transit Oriented Development (TOD) concept. This concept emphasises that transit points allow passengers to change modes, for example, stations and airports or terminals, making it easier for tourists coming from outside the city to Baturaden or other Bayumas tourist areas because currently, no transportation access connects stations, terminals, or airports directly with tourist sites [7], [8], [9], [10].

This research aims to formulate a conceptual model of tourism growth projections with the transportation facilities improvement in Banyumas Regency. This model will later show how tourism growth is projected with transportation facilities improvement and its impact on other variables related to tourism growth by showing the relationship between tourism growth and other variables. This model can also be a source of information in decision-making or plans for future tourism development regulation by the Banyumas Regional Government. It could be a base model for other stakeholders regarding the problem of increasing tourism through improving the transportation system. System dynamics can also simulate this model to see the behaviour of scenarios run from historical data, TOD transportation development policy scenarios, or other policies such as sustainability policies. This formulation will use the Causal Loop Diagram (CLD) approach, the basic system dynamics method.

A holistic approach is needed to develop a projection model. It can consider the interactions and relationships between factors that influence tourism growth with transportation facilities and infrastructure improvement in Banyumas applied. Transportation infrastructure is the basis for the successful creation/ establishment of new tourist locations in line with the development of transportation infrastructure in the surrounding area [11]. The resulting projection model can provide an overview of the growth of tourism and transportation system improvement in Banyumas over a certain period. It can also offer policy recommendations that local governments can implement to develop sustainable tourism and transportation infrastructure in Banyumas.

Methods

The system dynamic concept models the complex interactions between various factors influencing tourism growth and transportation system improvement in Banyumas Regency. Tourism growth is associated with factors such as the number of visitors, the availability of accommodation facilities, tourism promotion, and tourism policy. This research used a system dynamic approach because it can model complex interactions between various factors that influence tourism growth and transportation infrastructure in the Banyumas Regency. In addition, this approach also makes it possible to consider long-term dynamics and trends in the development of tourism and transport infrastructure. A Causal Loop Diagram has been used as part of the system dynamics method to help the decision-making process in choosing a better policy by understanding the complexity of the system and its consequences for the variables involved. The Causal Loop Diagram is the prior stage of system dynamics that created a model representing the real interaction between each stakeholder and variable involved. This model can be used to simulate the dynamic behaviour of some regulation implemented and other variable linkage model methods [12].

The formulation of the causal loop diagram model was carried out by collecting reference models, which will form a mental model that allows the conceptualization of the model to be described more clearly between individuals or groups, as well as making it easier to communicate important feedback on the structure as the source of the existing problem [12]. The existence of a Causal Loop Diagram helps to fully describe what variables work in the system and the relationships between these variables. CLD diagrams can also describe the polarity of relationships between variables so that you can find out which are positive or negative feedback loops [13]. In other words, the diagram can represent a hypothesis of a system structure that feedback by considering certain considerations. It can also be used to create an understanding of the same mental model between members in the same group or organization.

Causal Loop Diagrams have been widely used in research to model a system and its relationships, especially in tourism supply chains that are different from typical supply chains have a high level of complexity and involve many stakeholders. [14] used the CLD approach in system dynamics to demonstrate the dynamics of developing multiple tourism destinations with competitiveness and cooperation variables and their relationship with investment in transportation infrastructure. [15] The CLD approach was used in a dynamic system combined with service quality to improve the quality of tourism in Surakarta, which can facilitate decision-making to implement alternative quality improvements that have the most significant and effective impact on increasing the number of tourists in Surakarta. The researchers conducted by [16], [17], [18] used CLD modelling to provide alternative decisions in improving tourism by engineering improvements in certain sectors and then analysing the resulting impacts through the resulting system behaviour.

Tourism development in Banyumas Regency is influenced by many variables in the tourism supply chain, including the transportation system facility and infrastructure. The Transit-Oriented Development (TOD) concept is used as an effort to improve transportation facility and infrastructure because this concept has now been widely accepted in Indonesia for the development of urban areas that efficiently integrate land use planning and transportation systems with its eight aspects: Connect, Compact, Transit, Densify, Shift, Mix, Cycle, and Walk [19]. One of the most important aspects of the TOD concept is the accessibility and connectivity of residents who are need to travel here and there on many occasions. [20] states that implementing the TOD concept can increase equitable accessibility in urban development through less travel time. This concept also increases the usability of public transport, the expansion and better quality of non-motorized transportation, helps compact land development and prevents uneven land use planning, and strengthen economic activities through the productivity of public transport use [10], [21], [22], [23].

This research is the primary stage of system dynamics modelling to forecast Banyumas tourism development, which is high complex. Furthermore, this research was carried out in some steps, such as: (i) model adaptation and creating a mental model, determining the topic and scope of the research and literature review collection of tourism supply chain models and transportation systems, especially TOD, then collect related mental model formations; (ii) Expert perception reference, the validation of the model created; (iii) system description, the definition of current tourism supply chain and transportation system, its linkage and stakeholder related; (iv) actor analysis, explaining the stakeholders and roles involved on the models; (v) system diagram framework, shows overall related to the model formulation on each previous stage; (vi) Causal Loop Diagram, the final formulated model of Banyumas tourism supply chain with transportation system improvement, which represents the current condition and related variable.

Results and Discussions

Model Adaptation and Creating A Mental Model

The formulation of a tourism growth projection model through the improvement of the transportation system is carried out by collecting mental models from several system dynamics models of tourism supply chain and transportation systems (Sterman, 2000). Mental model formulation can be obtained from several sources, including related literature studies and through semi-structured interviews with stakeholders, as shown in Table 1.

In formulating a tourism supply chain model, several expert from stakeholders involved are needed as well as variables and linkages that can be proven to compile variables and connectivity relationships in the CLD formulation. The tourism supply chain is unique and different from the typical supply chains, which usually consist of suppliers, manufacturers, distributors, retailers, and consumers. Still, in the tourism supply chain, there are main points, namely pre-departure, during travel, and post-departure, according to the process. The main business of tourism involves travel and visits to tourist destinations [38].

Table 1. Adaptation of research models to model formulation

References	Purpose	Adoption
[24]	Provide a review of dimensions of transport system at the destinations: the various dimensions and how transport is used for tourism purpose	Determine the variables, stakeholders and elements involved to formulate tourist destination sub-models and transportation system sub-models
[25]	Plan a management proposal for Yogyakarta's urban transportation system by reviewing the urban transportation system at a macro level through public transportation modes and restrictions on private transportation modes	Determine the variables, stakeholders and elements involved to formulate the transportation system sub-model and determine the strategic intervention
[26]	To determine the influence of facilities, transportation and accommodation partially but simultaneously influences tourist satisfaction in Semarang regency	Determine the variables, stakeholders and elements involved to formulate the tourist destination sub-model, accommodation sub-model and transportation system sub-model
[27]	To present and classify the current body of knowledge that useful for TSM research and to develop a research framework in TSM	Determine the variables, stakeholders and elements involved to formulate the tourist destination sub-model
[28]	To explore the extent to which the SD approach has been implemented in the planning and development of the tourism industry	Determine the variables, stakeholders and elements involved to formulate the tourist destination sub-model
[14]	To demonstrate the dynamic development process of multiple tourism destinations, which evolves the competition and the cooperation relationship of transport infrastructure investment	Determine the variables, stakeholders and elements involved to formulate the tourist destination sub-model
[15]	Improve service quality by adding an interactive platform, held events and promotion would enable policy maker to stay in line with tourists needs and invest in accordance with their wants which leads to significant improvement in the quality of the service offered to tourists	Determine the variables, stakeholders and elements involved to formulate the tourist destination sub-model and hospitality industry sub-model
[8]	To determine the transportation infrastructure mode, the benefits of railway transportation, the possibility of high cost of railway infrastructure be a commercially feasible transport mode in Asia and the financial of high cost of railway infrastructure	Determine the variables, stakeholders, elements involved and integrate the relationships between variables to formulate a transportation system sub-model with TOD strategy
[10]	TOD in Kali Besar area extent the visitors perceived the transit connectivity and accessibility (including walkability) in Kali Besar area after revitalization in 2018 and how its affect the willingness to revisit Kali Besar in the future	Determine the variables, stakeholders, elements involved and integrate the relationships between variables to formulate tourism supply chain sub-models, transportation systems and TOD strategy variables
[18]	To necessarily address real causes for the occurrences of the potential problem of policy affecting performance of Zhouzhuang cultural tourism	Determine the variables, stakeholders and elements involved in formulating infrastructure, infrastructure development and improvement in the tourism supply chain model formulation
[16]	Explore the dynamic behavior patterns (dynamics) of a generic value-chain management (VCM) structure to unearth what Cyprus' tourism, including its hotels and their suppliers	Determine the variables, stakeholders, elements involved and integrate the relationships between variables to formulate tourist destination and accommodation system sub-models
[17]	To study threats to the Galapagos Islands because of the increasing pressure of the human sub-systems on the natural environment, originating from the explosive development of tourism within the Archipelago	Determine the variables, stakeholders, elements involved and integrate the relationships between variables to formulate a tourism supply chain model
[29]	To propose a dynamic system for demand forecasting of the transportation system by involving population growth variables	Determine the variables, stakeholders, elements involved and integrate the relationships between variables to formulate the transportation system sub-model and determine the interventions involved
[30]	To provide a modeling framework based on the system dynamics (SD) approach by which policymakers can understand the dynamic and complex nature of the policy influence within a transportation socioeconomic system representation of a metropolitan area	Determine the variables, stakeholders, elements involved and integrate the relationships between variables to formulate the transportation system sub-model and determine the interventions involved

References	Purpose	Adoption
[31]	To provide a comprehensive and objective assessment of improving reliability of transportation systems and its impact to reduce traffic congestion	Determine the variables, stakeholders, elements involved and integrate the relationships between variables to formulate transportation system sub-models and determine transportation infrastructure and facility improvement interventions
[32]	Uses scenario through reconfiguration of network routes to improve the efficiency of the transportation system	Determine the variables, stakeholders, elements involved and integrate the relationships between variables to formulate transportation system sub-models and determine transportation infrastructure and facility improvement interventions
[33]	Produce a comprehensive picture of transportation system in Pekanbaru in terms of traffic generation and attraction, then the recommendations related to transportation problems that need to be addressed immediately	Determine the variables, stakeholders, elements involved and integrate the relationships between variables to formulate transportation system sub-models and determine transportation infrastructure and facility improvement interventions
[34]	Making policies in accordance with tourism needs in Maluku as an archipelagic province to support the smooth running of the tourism industry that requires good synergy between the government, stakeholders, and local communities	Determine the variables, stakeholders, and elements involved and integrate the relationships between variables to formulate transportation system sub-models and tourist destination sub-models as well as determine interventions to develop tourism
[35]	Evaluate the strengths and weaknesses of system dynamics (SD) with respect to its suitability, appropriate transportation modelling, and better understanding relationships between elements of the transport system and between transport and its environment then it can be applied to construct useful tools for testing alternative transport-related policies	Determine the variables, stakeholders, and elements involved and integrate the relationships between variables to formulate transportation system sub-models and determine transportation strategy interventions
[36]	To simulate the evolution of urban transportation system, specifically the impacts of vehicle ownership policy on urban transportation development in Dalian Central City as an example	Determine the variables, stakeholders, elements involved and integrate the relationships between variables to formulate transportation system sub-models and determine transportation strategy interventions
[9]	Identify and examine how TOD can increase the use of transit modes and transportation efficiency	Determining variables in the TOD strategy in the transportation system model formulation
[37]	To propose a conceptual framework for supply chain modelling and simulation that uses major attributes: the life-cycle phase of the supply chain and associated applications, the hierarchical level of detail, and the supply chain process flows	Determine the variables, stakeholders and elements involved to formulate a supply chain model
[24]	Sets out a review of over 50 peer-reviewed journal papers since 1994. The fields of application include the take-up of alternate fuel vehicles, supply chain management affecting transport, highway maintenance, strategic policy, airport infrastructure, airline business cycles, and a set of emerging application areas	Determine the variables, stakeholders, and elements involved and integrate the relationships between variables to formulate the transportation system sub-model and supply chain sub-model and determine the interventions involved

Expert Perception Reference

The Mental model was collected through study literature and supported by semi-structured interviews with stakeholders. Then, the expert perceptions need to validate the mental model so the model created can represent the actual condition of the Banyumas tourism supply chain and Banyumas transportation system regarding the transportation system improvement policy plan. Expert discussions can also determine system boundaries and validate the appropriate model structure. The experts who validated this model come from stakeholders who have been experienced for more than seven years in each field, including Banyumas Tourism Department, accommodation industry players, F&B industry players, tourist attraction players, and Banyumas Transportation Department. Based on the collection of mental models obtained through expert interviews, several system perceptions can be concluded that can be used to build research models, namely:

1. Current tourism development mostly relies on the development of the tourist destination itself and the development of the accommodation and F&B industry.
2. Currently, the Banyumas Regency Transportation Service has provided integrated transportation facilities at several points to facilitate mobility and has provided public transportation on Banyumas' mainstay tourism route, namely Baturaden.
3. Public transportation routes do not provide specific stops at tourist destinations but still go to certain points to get to tourist locations. The tourists still need to use other means of transportation, for example, *angkot* (city public transport) and angkudes (village public transport).
4. The availability of public transportation, both in terms of quantity and availability, also influences the use of transportation, apart from public transportation rates.
5. There are no efforts to improve public transportation infrastructure and facilities, especially regarding transportation integration and operating times.

The validation process of the model is done by interviewing experts with the model built from a mental modele. Then the experts will validate or revise every loop on the causal loop diagram as model used. The validation process is similar to Forum Group Discussions (FGD) because every expert's perspective of the model built remains important. The experts have many activities involved in building this model. The FGD is held many times, starting from collecting the mental model to model validation. The mental model collection activity involving the experts should sometimes be held separately for some stakeholders, and then it takes more time to collect.

The mental model and expert's input provide a conclusion in the form of a dynamic research hypothesis. The dynamic hypothesis of this research is used to provide representative results from a model that has been formulated based on the variables involved and the relationship between interacting variables [12].

The dynamic hypothesis of this research is that the development of the transportation system in terms of infrastructure and public transportation facilities can influence the development of the tourism industry and supporting fields, including the accommodation industry, F&B and the tourist destination or location itself. Furthermore, the development of supporting industries and the tourism sector will increase tourist visits and tourism revenue. The increase in tourism revenue can then be a turning point for improving facilities and infrastructure for all stakeholders in the tourism supply chain, which will also experience an increase.

System Description

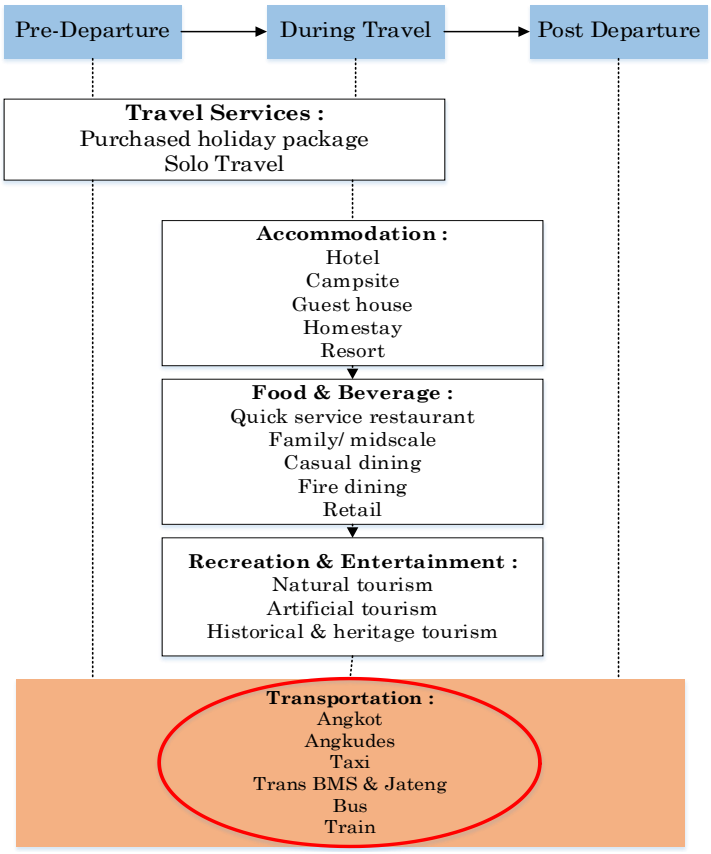

Figure 1. Banyumas tourism supply chain

There is no typical supply chain in the tourism industry. Still, based on the conditions of Banyumas tourism, we developed a tourism supply chain model shown in Figure 1. The basic model of the tourism supply chain in Banyumas was developed based on Westcott & Tourism's supply chain model and divided into three stages, namely pre-departure, during travel and post-departure, which were adapted to the conditions in Banyumas Regency [38]. The tourism supply chain usually involves tourists, transportation, tourist destinations, food and beverage, and the accommodation industry. Apart from that, the complexity of the tourism supply chain is also added to by managers who are both government and private parties. Banyumas is one area with a lot of tourism potential for further development in Central Java province. One of the areas most visited by domestic tourists is Central Java Province, with 25.27 % of all trips made by domestic tourists in Indonesia. When viewed based on districts/cities, the area in Central Java Province, one of the areas most visited by domestic tourists and which is also developing its tourism potential, is Banyumas Regency.

Even though transportation is the main factor whose role is to determine the increase in tourism in the tourism supply chain, which describes travel, efforts to increase improvements are quite difficult because they involve many stakeholders and variables. Several efforts can be made to improve the transportation system by improving public transportation in Banyumas, including improving physical facilities such as providing bus stops, extending operational times, and applying TOD by increasing routes and integration.

System diagrams provide a complete understanding of the system model being built more easily. All elements related to the system that will be built are shown in the system diagram, such as goals, problem owners, stakeholders involved in achieving system goals, possible interventions, and processes. A system that involves system input and output that is processed based on relationships between cause and effect and development.

Actor Analysis

To create a system diagram, an actor analysis is required first, which can define the roles and responsibilities of each actor / stakeholder involved, as shown in Table 2. This actor analysis can also show the influence of the actor / stakeholder on achieving goals and identify system boundaries.

Table 2. Actor analysis

Actors	Roles/ Responsibilities	Problem Perceptions	Objectives
Tourist visitor	Contributing to the tourism industry and revenue	Decreasing number of tourist visitor due to seasonal trend and other unsupported factors	Increasing infrastructure improvement and investment
Recreation & Entertainment (Tourist attraction industry)	Providing recreation and entertainment place as a tourist attraction	Failure to provide diversity of tourist attraction and maintain the operational service and facility	Increasing service improvement, infrastructure improvement and investment
Accommodation industry	Providing hospitality service to tourist visitor during departure stage of visit	Failure to provide diversity of hospitality service and maintain its facility	Increasing service improvement, infrastructure improvement and investment
Food & Beverage Industry	Providing, supplying, and selling food and beverage to tourist and accommodation industry	Failure to provide diversity of food and beverage due to the difficulty of food material supply and fluctuation price	Using multiple suppliers to prevent food material shortage
Transportation department	Creating transportation network and policy to improve tourism connection with existing transportation mode	Lack of service and infrastructure due to limited investment	Proper transportation infrastructure
Transportation industry	Providing different modes of transportation mode	Lack of transportation mode and routes	Ensure customer has a lot of choice of transportation mode and route
Travel agent	Organizing and suggesting travel package including tourist attraction, accommodation, and F&B	Limit exploration of recreation & entertainment (tourist attraction)	All customer requests can be fulfilled

Apart from the analysis actors, system boundaries also need to be created to be able to build a causal model and its development by grouping the variables involved into exogenous, endogenous, and excluded variables as shown in Table 3. Exogenous variables are variables that the owner of the problem cannot control, and the endogenous variables are all variables involved in the system that can be controlled by the problem owner in

the system process and exclude the variables that are not considered and have an influence on the model. These variables are then used to create a causal loop diagram without considering exogenous variables as a system boundary.

Table 3. Variables of system

Exogenous	Endogenous	Exclude
Number of tourist visitor	Destination capacity	Other tourism support facility
Spending	Tourism revenue	Other tourism industry
Length of stay	Destination price	Government policy intervention
Transportation system	Destination development rate	Tourism sustainability
	Destination infrastructure & facility existing	Marketing & promotion
	Destination infrastructure & facility	Aviation industry
	Spending cost	Train
	F&B price	Road infrastructure and condition
	Accommodation price	Traffic density
	Accommodation development rate	Travel time
	Accommodation diversity	
	Accommodation capacity	
	Accommodation service	
	Accommodation infrastructure & facility	
	Accommodation infrastructure & facility existing	
	F&B development rate	
	F&B diversity	
	F&B capacity	
	F&B existing number	
	Food supply	
	Public transportation Infrastructure & facility	
	Transportation user	
	Vehicle volume	
	Congestion	
	Public transportation user	
	Public transportation capacity	
	Private vehicle user	
	Private vehicle capacity	
	Bus station	
	Operation time	
	Public vehicle capacity	

System Diagram Framework

The system diagram is built based on actor analysis and grouping of variables involved in the system, as well as mental model processing that has been carried out previously [39]. Figure 2 shows the tourism supply chain system diagram to increase tourism development through improvements to transportation system facilities and infrastructure, which can be seen in the number of visitors, tourist revenue, tourist location capacity, and F&B capacity. F&B can be said to be an indicator of increasing tourism because nowadays, sometimes tourists not only visit with the aim of visiting natural, man-made or historical tourist locations but also with the aim of culinary tourism.

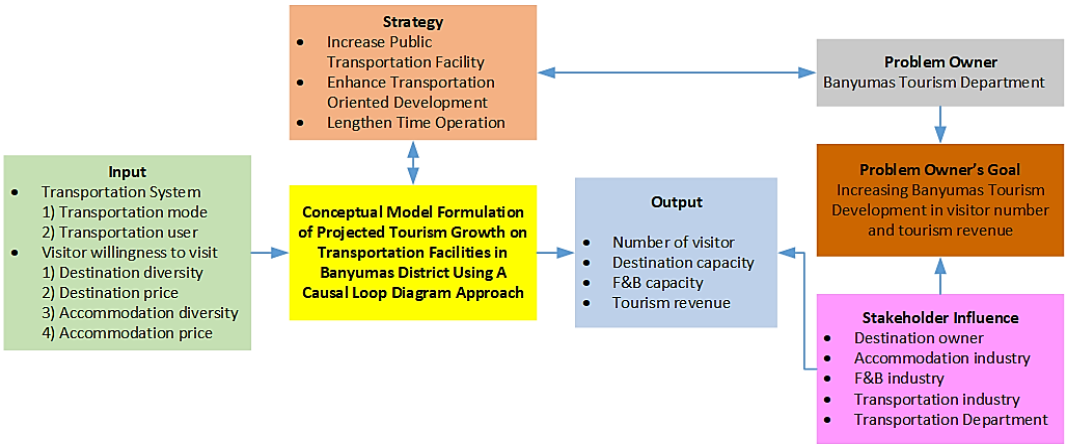

Figure 2. System diagram of transportation system development in the supply chain tourism

Determining policy interventions to model projections is carried out without considering exogenous variables. The policy intervention diagram system that will be used is shown by strategy: increase public transportation facilities, enhance TOD, and lengthen time operation. Each strategy will later be re-elaborated into a policy intervention, which can be input for problem owners and related stakeholders. The diagram system can also develop a chain model formulation tourism supply by developing intervention factors and other main variables.

Causal Loop Diagram

The causal loop diagram model is a formulation resulting from this research that describes reciprocal relationships. The designed model formulates variables in the tourism supply chain with transportation system improvement so that the impact of changes in transportation strategy variables on tourism development can be known. The formulation of tourism growth projection models in the tourism supply chain and transportation system is based on mental model model sources. The causal loop diagram of the model is shown in Figure 3.

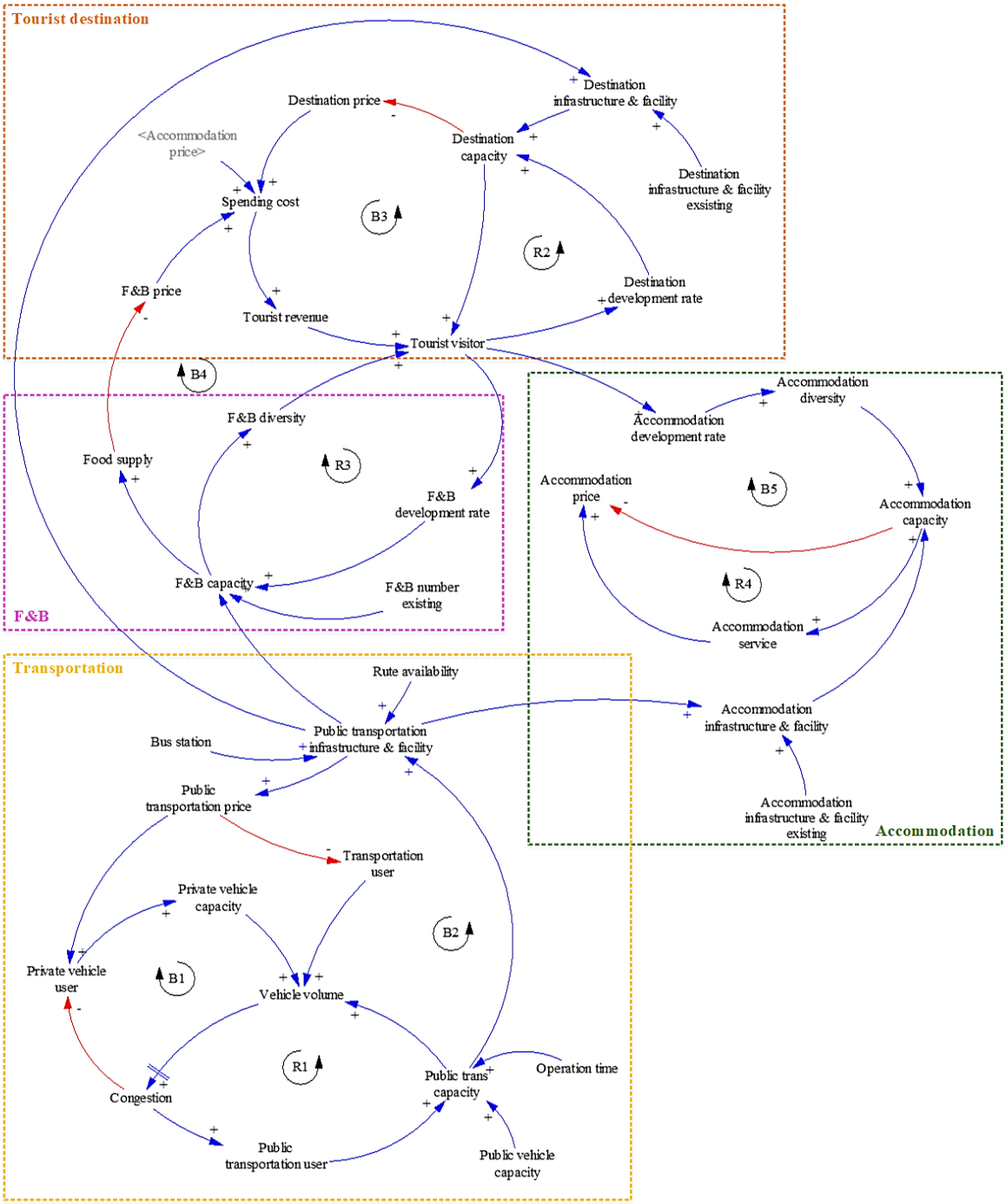

Figure 3. Causal Loop Diagram of Banyumas tourism supply chain with transportation system improvement

This causal loop diagram contributes to policymakers as a tool that helps understand the critical effects and causes of the decision made shown by its linkage. For researchers, this diagram can be a model development of tourism projection. It can be developed into a specific diagram as a mental model in the tourism supply chain, such as accommodation and the F&B industry. Then, the researchers can develop this holistic model to determine and see the system's behavior.

The causal loop diagram of the Banyumas Tourism Supply Chain in the context of Transportation System Improvement in The Supply Chain Tourism consists of four sub-systems, namely the tourist destination sub-model, F&B sub-model, accommodation sub-model and Transportation sub-model with a total of 4 reinforcing loops and 5 balancing loops. A Reinforcing loop is a circle that strengthens each other, while a balancing loop is a contradictory or decreasing relationship [12].

Tourist Destinations Sub-Model

The tourist destination sub-model is a model that shows the relationship between variables and tourist destinations in Banyumas. This sub-model has two loops, namely reinforcing and balancing. Loop R2 focuses on tourist visitor development from its destination, both in terms of development and capacity. Loop B2 explains how price and spending costs contribute to tourist revenue and tourist visitor development. This sub-model is the highlight of the Banyumas tourism supply chain, which can be developed again so that in this sub-model, there are output indicators or outcomes from policy interventions made towards the development of tourism in the Banyumas Regency.

F&B Sub-Model

The F&B sub-model is represented by one reinforcing loop that shows the F&B capacity that influences F&B diversity and development rate and, finally, the existing F&B impact on tourist visitor numbers. This reinforcing loop explains that when there is an increase in one variable, the other variables also increase. Based on this loop, it can also be seen the availability of food supply and its influence on F&B prices, which also influences spending costs.

Accommodation Sub-Model

The sub-model accommodation model consists of one reinforcing loop and one balancing loop. Loop R5 shows increasing accommodation capacity, which is influenced by improvements in infrastructure and accommodation facilities. This improvement also includes improvements to service delivery, thereby improving accommodation services. With good accommodation services, accommodation companies have higher competitiveness in terms of service, so they can increase accommodation prices because they are proportional to the services they receive. Loop R4 explains that the capacity of accommodation can be increased through improving infrastructure and facilities. This increase in accommodation capacity is represented by the number of accommodations available, so the more accommodation available, the more competitive the price given will be, so it has a negative relationship.

Transportation Sub-Model

The transportation sub-model represents the existing transportation system, especially the public transportation system in Banyumas, through two balancing loops and one reinforcing loop. Loop R1 shows that the number of public transportation users influences the development of public transportation capacity. Increasing public transportation capacity affects vehicle volume, which can increase traffic density. In this sub-model, there are efforts to improve transportation facilities through increasing public transportation capacity. The proposed policy interventions can be included in this sub-model, which are (1) increase public transportation facilities by increasing the number of bus stations and public vehicle capacity; (2) enhance TO by increasing the route available and better cover tourist attractions; (3) lengthen time operation of public transportation then the tourist attraction operation time can also be lengthened.

Conclusions

This research formulates a Banyumas tourism supply chain projection with the transportation system improvement through a causal loop diagram model. The relationships between the variables involved are illustrated by a causal loop diagram involving five balancing loops and four reinforcing loops. These loops include

the current conditions of Banyumas tourist destination, F&B industry, accommodation industry, and transportation system. The conceptual model aims to enhance Banyumas tourism development with transportation system improvement through increasing transportation infrastructure and facilities. This goal is achieved through a causal loop diagram influenced by the destination owner, accommodation industry, F&B industry, transportation industry and transportation department. Indicators of achieving the objectives of the conceptual model are shown through the output number of visitors, destination capacity, F&B capacity, and tourism revenue. Then this model can be a holistic model to policymakers on developing Banyumas tourism.

This study's limitations are that this model only considers the broader variable of every loop, doesn't consider the marketing factor, environment, and social economic development factors. This model can be different for other regions or a broader system, such as a tourism supply chain. This study only creates a basic model of transportation development in the Banyumas tourism supply chain that can be continued to determine the behaviour system. This research can be continued by using system dynamics simulation through SFD (Stock and Flow Diagram) [40].

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