A Study on 5G Service Methods by using BOCR Model and ANP

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Abstract

Recently, South Korea preferentially allocated frequencies to build 5G networks as a core competitiveness of the 4th Industrial Revolution. Although the government recognize the importance of 5G construction and preoccupation, network operators have limited to some services, testing the possibility of practical use of 5G. They hesitated to actively build and to carry out the service of a complete 5G network. While 5G is being developed and standardized like this, no one is sure of this step exactly what 5G will be. Thus, following research questions are asked by various stakeholders of 5G market: What is an ideal service providing method for the practical use of 5th generation mobile network? And what are the critical elements to be considered when selecting the service providing method? Therefore, the study aims to investigate 5G service providing issues and elements to be considered and to provide most appropriate service providing method for the practical use of 5G. The results identify that 'Specialized Service' is most appropriate method at the aspects of benefit and opportunity as well as the aspect of risk. In addition, the outcomes imply that the experts replying to the survey not only expect the expansion of emerging market, but also concern the social risk and cost. Since the study dealt with economic, social and business issues in providing 5G service, it might contribute not only to practical research, but also to academic research regarding 5G service method.

Keywords: 5G Service, Specialized Service, Paid Prioritization, Simplified Service, Traffic Management

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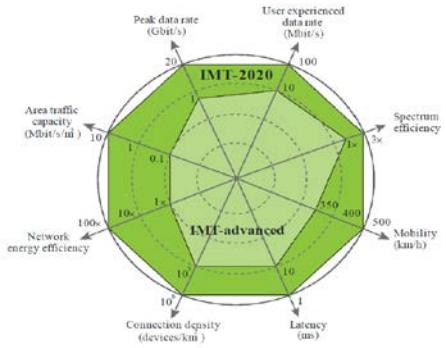
1. Introduction

In recent years, the world has established and competitively implemented a national-level promotion strategy for the early adoption of digital telephones and the establishment of a generation network as a core competitiveness of the 4th Industrial Revolution [1]. South Korea preferentially allocated frequencies to build 5G networks, followed by many other countries such as Germany and Australia. In the case of South Korea, the world's first 5G network was opened in December, 2018. As of June 2019, the era of 1 million 5G subscriptions is just around the corner [2].

Although the government recognized the importance of 5G construction and preoccupation, it was not easy to push network operators to construct complete 5G. Despite such a leading 5G opening in Korea, users are not aware of the significant difference from existing 4G services, so the users are not willing to pay additional costs for the use of 5G services [3]. Meanwhile network operators have limited to some services, testing the possibility of practical use of 5G. They hesitated to actively build and to carry out the service of a complete 5G network [3,4].



Source: ITU 2015[5]

Fig. 1. Enhancement of key capabilities from 4G to 5G

While 5G has been developed and standardized, as illustrated in **Fig. 1**, no one is sure of this step exactly what 5G is. Thus, following specific research questions are asked by various stakeholders of 5G market: What is an ideal service providing method for the practical use of 5th generation mobile network? And what are the critical elements to be considered when selecting the 5G service providing method? In answering those research questions, however, both research data to refer to the technology and infrastructure required for practical use of 5G and studies on business models that elicit customer demand and willingness to pay are insufficient [6]. In addition, academic circles do not provide sufficient reference materials for countermeasures against government policies and social consensus.

Therefore, the study aims to investigate service providing issues and elements to be considered and to provide most appropriate service providing method for the practical use of 5G. This study consists of the followings. First, in Chapter 2, core technology and regulation issues related to 5G were reviewed. Chapter 3 presented feasible and efficient 5G service providing methods from the perspective of network operators. In Chapter 4, the network model for the study was designed by applying the BOCR model to ANP. It investigated policy decisions on 5G deployment from the perspective of the criteria of benefit, opportunity, cost and risk. Chapter 5 presented both the priority for detailed factors that analyzed the network model using the ANP method and the appropriate service providing method for the aspect of each BOCR. Finally, Chapter 6 explained the reasons for recommending the proposed services.

2. 5G Service Providing Issues

2.1 Network Neutrality Issue

Network neutrality, first proposed by Tim Wu in 2003, refers to the principle that network providers should handle all content equally without any discrimination and that anyone can use the network fairly. It commonly contains regulations that prohibit physical traffic management activities that allow ISPs to block and regulate specific traffic [7]. It would be happened due to the limitations of the network band for additional considerations and different orders of traffic delivery. Therefore, it can be asserted that it has maintained a network neutrality policy around the world [7,8]. There is a conflict between the arguments that changes are needed because the existing network neutrality regulations and 5G are incompatible [9]. Generally, network operators are demanding deregulation. They used to claim that applying network neutrality regulations to 5G services is a barrier to practicality and activation. In response, content providers and civic groups refute that regardless of the 5G technological characteristics, network neutrality regulations should still be observed [9,10].
Despite of the evolved characteristics of 5G networks, however, domestic research is very sluggish. Countries that are rushing to establish 5G networks, including Korea, need to discuss in-depth whether network neutrality regulations, the most intensive regulations on wired and wireless Internet networks, are compatible with 5G.

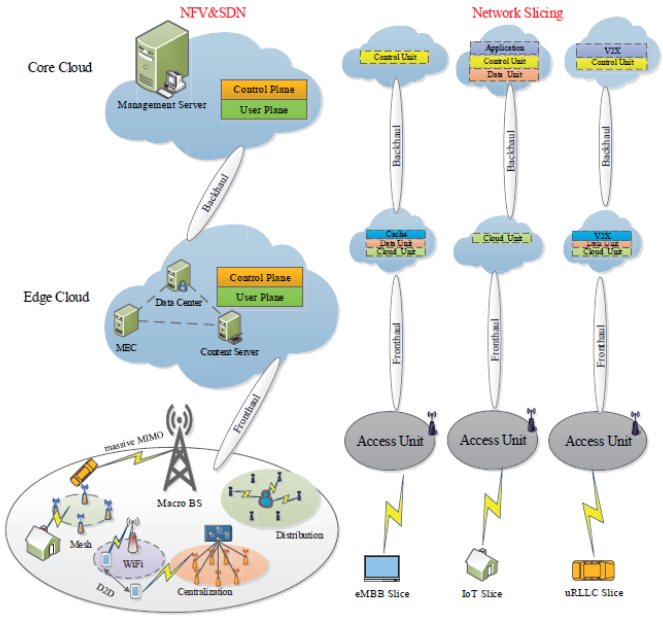
2.2 Zero-rating Issue

Zero-rating is a service in which content providers and telecommunication companies cooperate to reduce data usage fees for specific content. In terms of network neutrality, zero-rating has a potential problem that a few companies with large capital can dominate the market [11]. Even if small and medium-sized content providers produce high-quality content, it will be difficult to attract customers due to large companies that support free data fees. Major countries, including Korea, are diversifying their responses to network neutrality regulatory policies ahead of the commercialization of 5G, so it is time for social discussions on policy directions [12].
While the network neutrality regulation focuses on physically equivalent traffic handling, zero-rating is not a traffic management act, but a billing act. According to Cho (2020), CPs can also pay ISPs a certain price as needed and become gatekeepers themselves. Therefore, it is difficult to directly apply network neutrality regulations to zero-rating, which prohibit existing traffic management in advance [13,14]. In that case, policy changes in regulatory targets are inevitable. Priority processing activities by consideration include both commercial and traffic management activities. By contrast, although zero-rating is a commercial act, there is no traffic management act. For this reason, it was found that very few countries pre-banned on zero-rating and that many cases of conditional permission or post-regulation were chosen [15].

2.3 Technical Issue: Network Slicing

One of the various business models realized in the 5G era may enable each industry to be provided with a virtual network optimized for it [9]. Network slicing is a core technology that must be implemented to achieve the low latency, low energy consumption, and low cost required for 5G networks [16]. Network slicing is drawing attention as a representative technology of 5G. It is a technology that will realize enhanced integration between networks and services. Network slicing refers to a technology that provides network resources and

network functions in a single slice according to service types, giving independence and service customization attributes to mobile communication core networks and access networks [17].
5G can be deployed flexibly at a relatively low cost with cloud computing, NFV(network function virtualization) and SDN(software-defined networking) as core technologies, as shown in **Fig. 2**. Based on cloud and virtualization technologies, NFV can create, configure, and delete various forms of virtualized networks as needed, as a technology. It can dramatically solve not only technical problems but also cost problems for network expansion [5,16]. SDN refers to a technical concept, which can be controlled quickly and effectively [5,16]. The technology is also suitable for purposeful network operations and network security and traffic engineering.
Due to the technical nature of 5G's network slicing, continuous research is required on whether the logic of deregulation of network neutrality is possible or whether it can still secure the legitimacy of network neutrality regulation [17,18].



Source: Zhang et al. (2017)

Fig. 2. Network Slicing Example

3. 5G Service Providing Method

3.1 Specialized Service

The specialized service scheduled to be provided in the 5G network uses an Internet protocol called TCP/IP, but it is judged as a service rather than the Internet [9]. The best-effort Internet is regarded as the general Internet, but the managed service seems to be a premium Internet network. It is a service provided virtually or physically through a separate network from the best-effort Internet. This service refers to a premium method that allows only certain users to enter, ensures specific quality, and is used only for specific purposes. An important factor that distinguishes specialized services from the best-effort Internet is that it must be an independent network from the public Internet network [16]. In other words, the best-effort network should

not be negatively affected by the specialized service. Unlike the best-effort Internet, specialized services are services that must guarantee the quality required to provide specific services or applications. Thus, traffic management technologies are inevitably reflected to secure the quality. In conclusion, “specialized service,” a service method provided through a separate network, can deviate from the scope of network neutrality regulation as a managed service [9,18].

3.2 Paid Prioritization Service

Paid prioritization refers to the so-called "vertical priority". Under a contract to pay, the CP puts the CP's packet in the front row in a congested area, processes the packet first or later, or sends the ISP's own content first [9]. The similarity between the two services is that ISPs intervene in intentional manipulation, such as separate traffic management, to provide services with a certain level of quality [3,16]. And there is something in common in that CP must provide certain monetary compensation to ISP in exchange for quality guarantee. Specialized services form a separate network and do not affect the best-effort Internet network. However, since paid prioritization preferentially treats certain types of traffic, the other traffic inevitably slows down. This service method may conflict with the existing regulatory network neutrality [9,16].

3.3 Simplified Service using Satellite

Due to reliable delivery service, mobile services using satellites have recently attracted attention. Generally, best-effort Internet does not guarantee the delivered data quality among so many users. *SatelliteInternet* company asserts that using a satellite allow ISP to eliminate such the delivery problem [19]. Those kinds of companies are also making great efforts to meet the requirements of 5G services using a satellite. Thus, emerging best-effort service using satellite would be worthy for most business in near future.

Source: *SatelliteInternet* Homepage

Fig. 3. 5G service using Satellite

4. Research Design

4.1 The Identification of Pros & Cons for 5G Service

The government and network operators as well as the organizers of 5G network construction, are watching overseas trends due to the lack of reference materials in determining the implementation method. Therefore, it is necessary to establish a promotion strategy in consideration of benefits, opportunities, risks, and costs for 5G construction. This study identified specific elements through in-depth literature review and classified them, as expressed in **Fig. 4**.

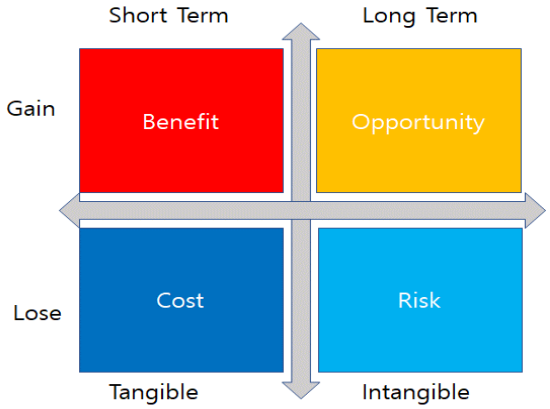


Fig. 4. BOCR Criteria Categorization

4.1.1 Benefit

As a benefit of 5G, user benefits are expected first. It can enable the emergence of various services that were difficult to implement in previous networks. In addition, not only telecommunication businesses but also companies in each industry can participate in ICT competition, which can increase user benefits by expanding competition throughout ICT. Network slicing technology for 5G can move away from the way to provide the same service to all users, to the way to provide customized networks according to the user's needs and nature of the service [1,2,3,4,15].

4.1.2 Opportunity

As a long-term and potential opportunity for 5G, it is expected that 5G networks and individual industries will converge to expand new business models in all industries. 5G stands for a technological leap to create a customized ecosystem, unlike the pursuit of fast network connectivity by the general purpose of existing networks. In terms of business, it aims to create new markets and profits for these customization needs [1,2,3,6,9].

4.1.3 Cost

5G construction requires huge construction investment costs for network operators, and in some cases, the rate is increased as a new service and customized service, which can act as an additional cost for users. In addition, since 5G requires the revision of existing laws, social discussions inevitably arise in various fields. This is suggested as a cost factor that increases social costs as conflicts can occur among various classes [3,4,16].

4.1.4 Risk

As a risk factor, there would be a risk of social confusion that can be caused if autonomous vehicles, IoT, etc. cause security or technical defects. In addition, since 5G uses a high frequency band, it is inevitable to build more base stations than now, which is expected to increase social risks due to severe environmental damage. There are also risks such as fair competition due to business conflicts between operators in the C-P-N-D class. With 5G marketing advanced, 5G service may infringe user rights, discriminate users, and distort the market competition [3,12,13,15], as listed in **Table 1**.

Table 1. Elements based on each BOCR Aspect

Criteria	Elements	Definition
Benefit	Efficiency of Resource Allocation [1], [2], [3]	Benefit of efficient resource sharing to enhance network performance
	Satisfaction of User Requests [1], [3], [4]	Benefit of fulfillment or customization for user requests
	Welfare for Users [2], [15]	Benefit of providing welfare to people as results of various 5G service
Opportunity	Expansion of Emerging Market [3], [6], [9]	Potential of new market expansion due to 5G service
	Reward for Investing (Business Model) [2], [3]	Potential of reward for investing with various business model
	Realization of Vertical Industry [1], [3], [9]	Potential of providing niche services for vertical industries
Cost	Network Establishing Cost [3], [4], [16]	Cost of network establishment needed for 5G service
	Service Operating Cost [3], [16]	Cost of software development or operating for 5G service
	Social Cost [3], [9],[16]	Cost to solve social conflict and environment disruption for 5G service
Risk	Infringement of User Rights [3], [13]	Likelihood of infringement of user rights
	Discrimination Risk [13], [15]	Likelihood of discrimination of users due to the traffic management control
	Distortion Risk of Competition [12], [13]	Likelihood of competition distortion risk in market by altering consumer choice
	Social Confusion [3], [13], [16]	Likelihood of social confusion due to any technical imperfection

4.2 Network Model Design

To derive an ideal service providing method for the practical use of 5G, the study designed the network model, which composed of the goal, main criteria, subnet, and alternatives, as illustrated in **Fig. 5**. And then 51 experts evaluated relative importance among BOCR criteria and subnet elements according to Saaty's guideline [19-22].

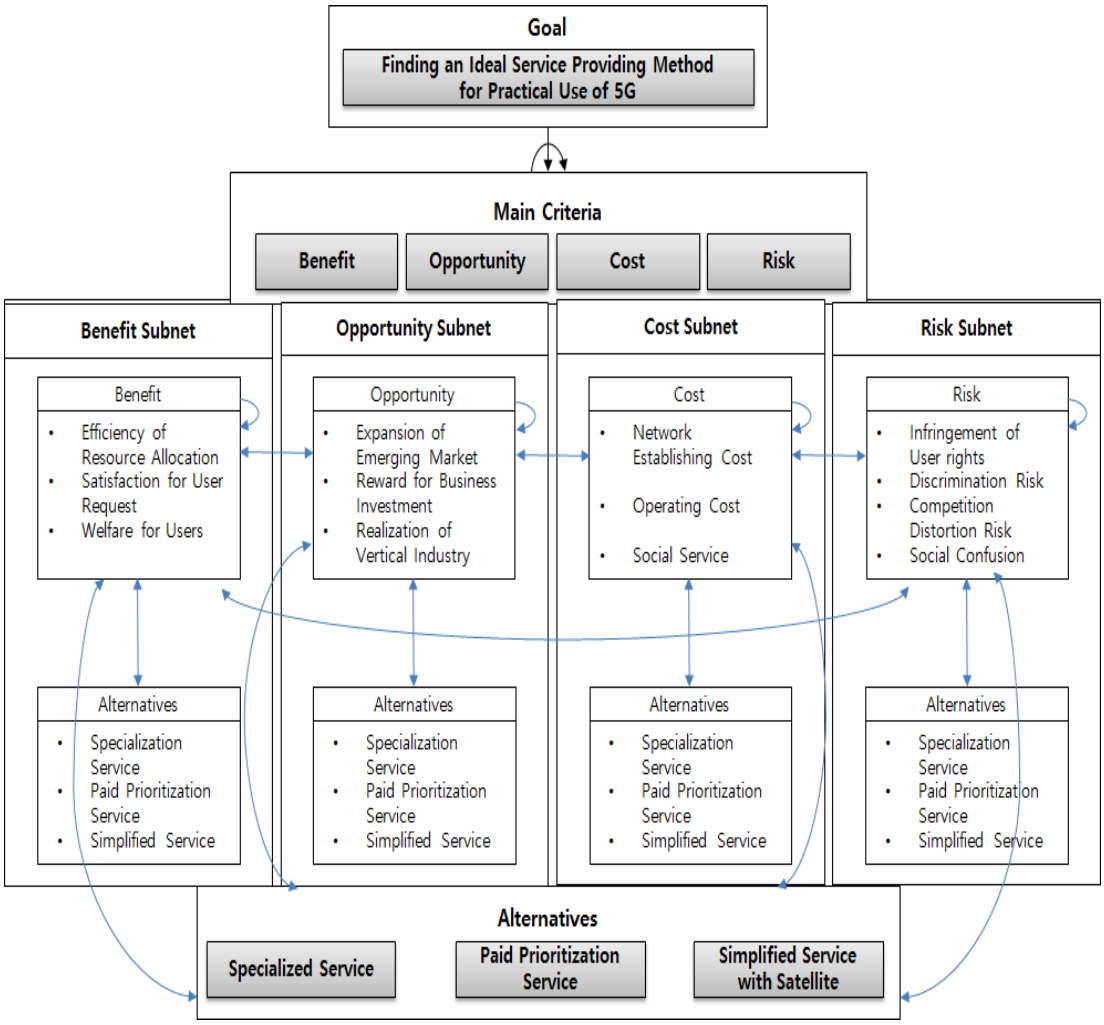


Fig. 5. Whole Network Model

There are three potential alternatives of service providing methods for the practical use of 5G. As proposed in previous section, the core services of 5G network would be specialized, optimized, or simplified, which include specialized service, paid-prioritization and best-effort service using a satellite. Above all, the ANP methodology for practical use of 5G was applied in this study. Then the alternatives were evaluated by super decision tool, the most frequently used to conduct ANP.

5. Outcomes

5.1 Priority of BOCR for the practical use of 5G

As illustrated **Fig. 6**, the weights of positive priority including benefit and opportunity exceed the weights of negative priority such as cost and risk. The result implies that most experts who replied to the research survey are expecting the advantages, rather than doubting the disadvantages for the practical use of 5G. The analysis reveals that the experts regard long-term positive effects as most critical factor for 5G service providing.

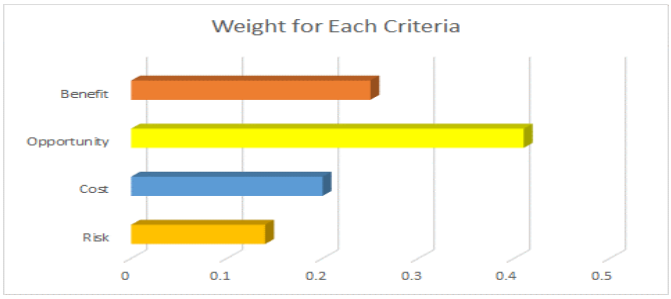


Fig. 6. Weight for Each BOCR Criteria

The study separately analyzes sub-elements in each BOCR criteria. At the aspect of benefit, 'Satisfaction of User Requests' is weighted as most important element in gaining immediate benefit for the practical use of 5G. And then it was evaluated in the order of 'Efficiency of Resource Sharing' and 'Welfare for Users'. It can be seen that 3 elements of benefit criteria were weighted at a similar level.
'Expansion of Emerging Market' seems to be the most frequently mentioned potential in terms of opportunity for 5G. And then it was evaluated in the order of 'Realization of Vertical Industry' and 'Reward for Investing'.

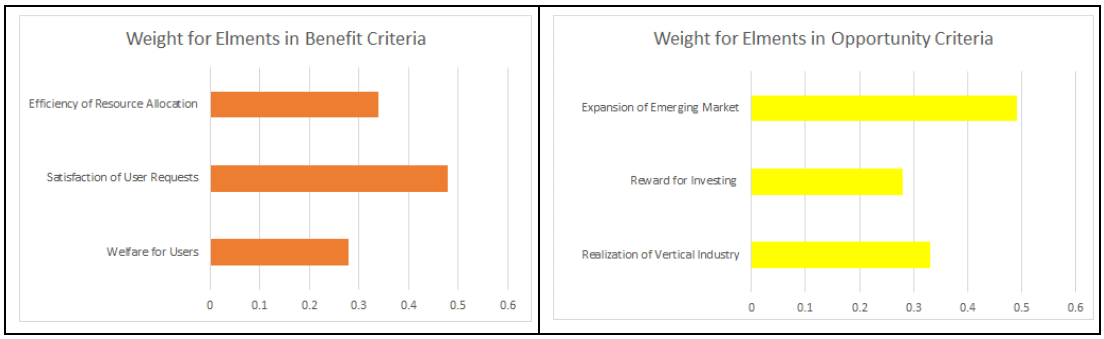


Fig. 7. Weights for Positive Elements

On the other hand, the analyses identify that 5G service might be vulnerable to not only confront at 'Social Confusion' due to technical imperfection, but also request financial burden such as 'Social Cost and Network Establishing Cost," The result also reveals that the experts regard 'Social Confusion' as the most vulnerable factor.

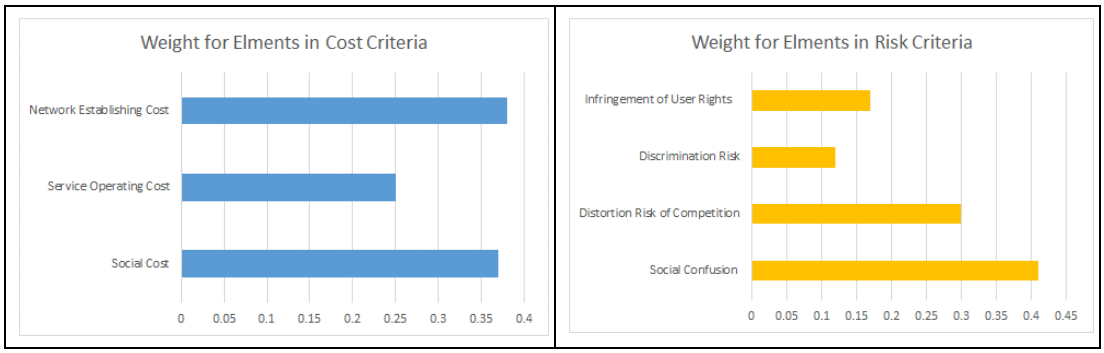


Fig. 8. Weights for Negative Elements

Fig. 9 illustrates the priority of multiplying the corresponding criteria weight for all subnet element weights. Above all, 'Expansion of emerging Market' was measured as the most positive element for the 5G service. And then it was evaluated in the order of 'Realization of Vertical Industry', 'Satisfaction of User Requests', 'Reward for Investing', 'Efficiency of Resource Allocation' and 'Welfare for Users'.

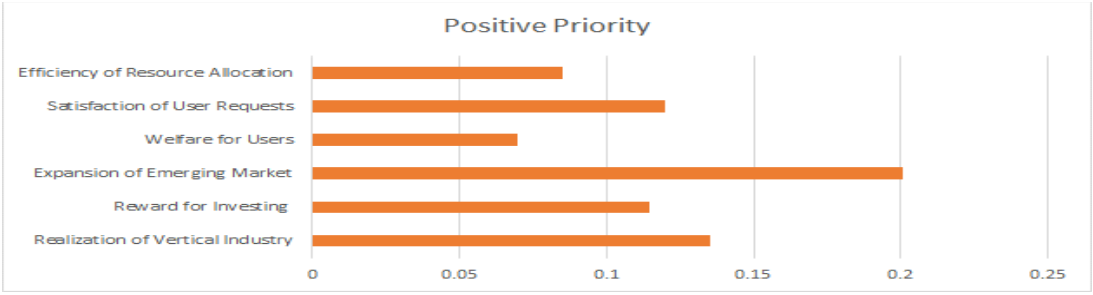


Fig. 9. Combined Weights for Positive Elements

'Social Cost' element was evaluated as the most negative treat for 5G service providing. At a similar level, the survey-participating experts regarded 'Network Construction Cost' as a significant negative factor. In addition, the result shows that 'Infringement of User Rights' seems to negatively affect 5G service providing at a minimum level.

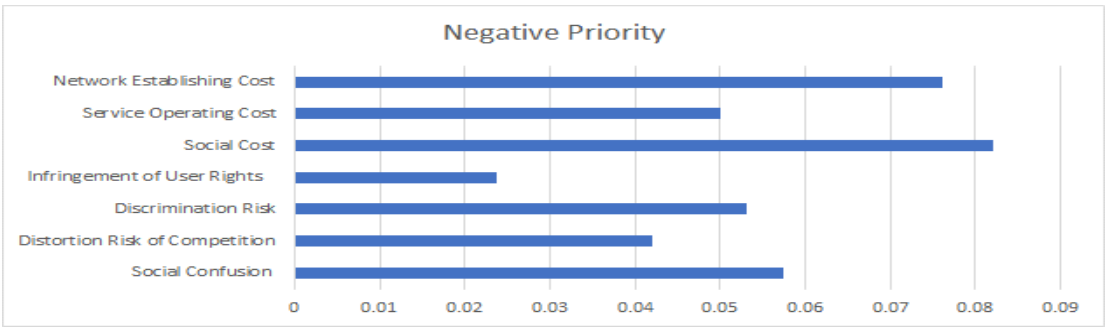


Fig. 10. Combined Weights for Negative Elements

5.2 Ideal 5G service providing method based on BOCR

The result of analysis in benefit criteria reveals that 'Specialized Service' is the ideal 5G service providing method with the highest weight. Based on evaluation in opportunity criteria, 'Specialized Service' seems to be the most appropriate 5G service providing method with the highest weight in the criteria. 'Simplified Service using Satellite' showed the lowest expectations in terms of benefits, and second order in terms of future market expansion opportunities. In the same vein, 'Paid Prioritization Service' gained the lowest expectations in terms of opportunity, and second order in terms of immediate benefit.

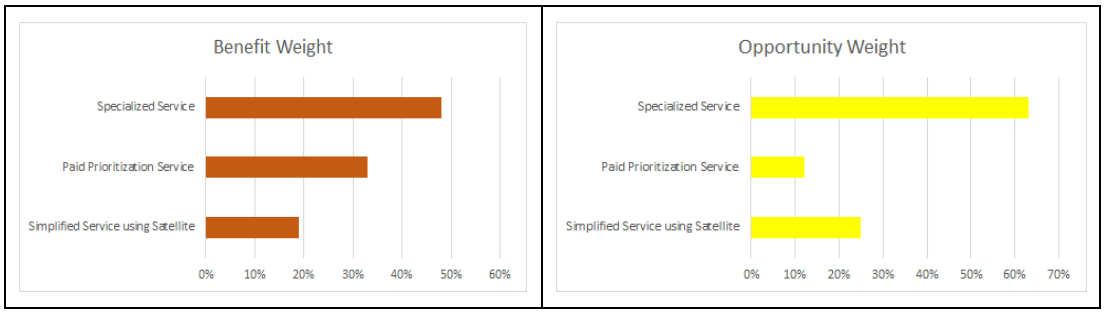


Fig. 11. Ideal Method for Benefit and Opportunity Criteria

The study identifies that 'Paid-Prioritization' is the most appropriate 5G service providing method at the aspect of costs with the lowest weight. And then it was evaluated in the order of 'Simplified Service using Satellite, and 'Specialized Service'. By the same token, the result of evaluation in risk criteria illustrates that 'Specialized Service' is the ideal 5G service providing method at the aspect of risk with the lowest weight. 'Simplified Service using Satellite' gained second order in terms of cost and risk.

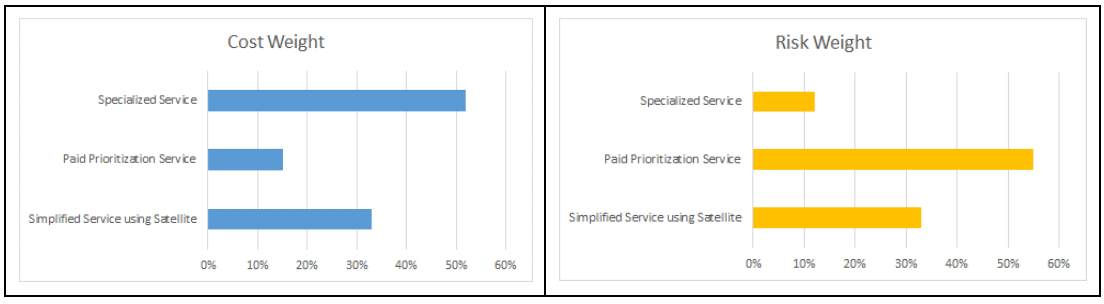


Fig. 12. Ideal Method for Cost and Risk Criteria

6. Conclusion

The study aimed to investigate service providing issues and elements to be considered and to provide most appropriate service providing method for the practical use of 5G. To achieve the research goal, the study established a promotion strategy in consideration of benefits, opportunities, risks, and costs for 5G service. ANP methodology for practical use of 5G was applied in this study. First of all, the study identified specific elements through in-depth

literature review, classified them, and designed the network model. The model composed of the goal, main criteria, subnet, and alternatives for the analyses. The core services of 5G network would be specialized, optimized, or simplified, which include specialized service, paid-prioritization, and best-effort service using a satellite. Then the alternatives were evaluated by super decision tool. The outcomes derived by analyses provided several implications as followings.

First of all, the results identify that 'Specialized Service' is most appropriate method at the aspects of benefit and opportunity as well as the aspect of risk. In addition, the study implies that while 'Paid-Prioritization' method is ideal in the aspect of cost with the lowest weight, it may be not only vulnerable to exposure the various risks, but also fragile to expect business opportunity.

The outcomes imply that 'Specialized Service' refers to a premium method that allows only certain users to enter, ensures specific quality, and is used only for specific purposes. That is, 'Specialized service' is the service that must guarantee the quality required to provide specific services or applications. 'Special Service' method utilizes network slicing technology which enables not only network operators to provide separate network to their customers, but also IT companies to participate with various business model [3]. In addition, 'Special Service' would be exposed to regulation risk at a minimum because the service uses independent network distinguished from the best-effort Internet [9]. That means the specialized network does not negatively affects the public network. Even though 'Specialized Service' requires the highest costs for network establishment and service operating, the study regards 'Specialized Service' as a totally ideal method for the practical use of 5G.

Secondly, the results identify that 'Paid-Prioritization' is the most appropriate 5G service providing method at the aspect of costs with the lowest weight and that the service gained the lowest expectations in terms of opportunity and second order in terms of immediate benefit. Paid prioritization refers to the so-called "vertical priority". Under a contract to pay, the CP puts the CP's packet in the front row in a congested area, processes the packet first or later, or sends the ISP's own content first. 'Paid-Prioritization' method often control the traffic management based on a pre-paid compensation [9,16]. Since the service method may give negative effects on the best-effort network, 'Paid-Prioritization' service is likely to conflict network neutrality regulation. Since paid prioritization preferentially treats certain types of traffic, the other traffic inevitably slows down [17]. This service method may conflict with the existing regulatory network neutrality and result in the likelihood of competition distortion. Moreover, the study implies that even though 'Paid-Prioritization' does not request so much initial costs, it will burden much more social cost.

Finally, 'Simplified Service using Satellite' shows the lowest expectations in terms of benefits, and gained second orders in terms of future market expansion opportunities and in terms of cost and risk. Generally, best-effort Internet does not guarantee the delivered data quality among so many users. These may result in the loss the benefits and business opportunities for 5G. Several companies, including *SatelliteInternet* company asserts that using a satellite allow ISP to eliminate the delivery problem [19]. Such kind of companies are also making great efforts to meet the requirements of 5G services using a satellite. Thus, emerging best-effort service using satellite would be worthy for most business in near future. The simplified service using satellite will be available nationwide, which may provide a popular way in rural areas.

In short, the study holistically dealt with economic, social and business issues in providing 5G service. The derived issues were also analyzed in connection with the 5G service provision method, applying BOCR model to ANP [20-22]. The study might not only to practically, but also academically contribute on 5G service method research.

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