Innovation Diffusion of Producer Institution to achieve better equity in furniture industry in Indonesia

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Abstract:

Furniture is a culturally rooted industry in Indonesia, where millions of people depend on it. The district of Jepara, Central Java is the center of furniture and carving activities in Indonesia. In many developing countries, the furniture industry is dominated by small-scale enterprises and is buyer driven. Small-scale enterprises adapt their processes and products to follow buyer's demand. Otherwise, they will not survive in the fierce market competition. An individual small-scale producer has low bargaining power against brokers and end buyers in selling their products. An effort to strengthen small-scale producers of furniture in Jepara, Indonesia has been facilitated by the establishment of the Jepara Furniture Small-scale Enterprise Association (APKJ) in 2009. APKJ is an institutional innovation which has organization, rules and activities. The APKJ innovation is attributed by relative advantages, compatibility, complexity, trialability and observability. This paper describes how APKJ diffuses to 12 thousand business units through chains of innovators, early adopters, early majority, late majority and laggards. A spatially explicit agent based modeling (ABM) was used to simulate the diffusion of APKJ innovation. The results show an S-curve of innovation diffusion. The theory of complexity as well ABM were useful in understanding common property. Although the model is specific to the Jepara furniture industry, its lessons and conceptual model can be implemented in other parts of the world.

Keywords: Innovation, institution, furniture, producer, small-scale enterprises

I. INTRODUCTION

Furniture making is the most labor-intensive industry in forestry. In 2011, the global furniture trade accounted for US$ 135 billion, or about 1% of the world trade in manufactured

goods. About 54% of furniture exports come from developing countries. China's share increased from 3% in 1995 to 16% in 2005 as illustrated (ITTO, 2006; CSIL 2008). Furniture is a sector where small and medium-sized enterprises (SMEs) have important roles. Globally, more than 90% furniture is made with the involvement of SMEs.

The livelihoods of five million people in Java, Indonesia depend on the furniture industry and its chains (Ewasechko, 2005). Any decrease in the furniture sector will increase poverty. On the other hand, growth of the furniture industry will increase the number of jobs available and therefore reduce unemployment. Purnomo *et al.* (2009) revealed that overseas stakeholders enjoy more value added than domestic stakeholders, while finishing and exporting companies take the biggest profit compared to SMEs and tree growers. Small-scale enterprises, indeed, enjoy the least value added. Purnomo *et al.* (2012) came up with four scenarios to improve valued added for small-scale producers i.e. moving up, collaborating down, green products and producer association. The last scenario was conducted through the establishment of the Jepara Furniture Small-scale Enterprise Association (APKJ) in 2009. APKJ was an institutional innovation aimed to improve the bargaining power of small-scale enterprises vis-à-vis brokers, buyers and government. APKJ diffusion is a social change. When APKJ was invented, diffused and adopted or rejected, it led to certain consequences toward social change.

Rogers (2003) defined diffusion as the process in which innovation is communicated through certain channels among the members of a social system over time. There are four identifiable elements of innovation diffusion: (a) innovation; (b) communication channel; (c) social system; and (d) time. An innovation is an idea, practice, or object that is perceived as new by an individual or society. Communication is the process by which participants create and share information with one to another to reach a mutual understanding. A communication channel is the means by which messages get from one individual to another. A social system is a set of interrelated members or units that are engaged in joint problem solving to accomplish a common goal. The members can be individuals, informal groups or organizations. 'Time' dimension involves innovation-decision process, innovativeness and adoption rate. An innovation diffuses through change agents to innovators followed by early adopters, early majority, late majority and laggards.

Agent-based modeling (ABM) is suggested to model common property (Janssen and Ostrom 2005). The ABM focuses on social dimensions, modeling particularly the human cognitive process. The hallmark of ABM is the recognition of 'agents', which are entities with defined goals, actions, and domain knowledge. Agents operate and exist in an environment. The environment might be open or closed, and it might or might not contain other agents. If it contains other agents, it can be seen as a society of agents. Simulating stakeholders' activities and interactions requires a tool that is able to represent the individual's knowledge, beliefs, communication and behavior. Individual agents are typically characterized as having bound rationality. They are presumed to be acting in what they perceive as their own interests, such as reproduction, economic benefit, or social status, using heuristics or simple decision making rules. ABM agents may experience 'learning', 'adaptation', and 'reproduction' (Purnomo and Guizol 2006).

This paper describes the innovation diffusion in the context of furniture industry in Jepara, Indonesia. The model utilized an agent based model (ABM) approach to understand how innovation diffuses among furniture actors including furniture producers, tree growers, retailers, government and non government organizations (NGOs) within the existing social system. Efforts to improve the adoption rate are suggested.

II. CONTEXT AND METHOD
2.1. Context

In 2011, there are 11,981 furniture business units of workshops, showrooms and warehouses throughout the Jepara district as shown in Table 1 (Achdiawan and Puntodewo 2011). The furniture industry, which processed 0.9 million m^3 wood per year, contributes about 26% of Jepara's economy. However, the trend of this industry was stagnant in terms of exported volume and value, as well as employment. Export value fell from $127 million in 2005 to $120 million in 20012. The industry mostly produced low value-added product and is categorized as a 'sunset industry' by the government. The SMEs have a low market position compared to the bigger players.

Table 1. Furniture enterprise types in Jepara (Achdiawan and Puntodewo 2011).

Type of business	Number
Independent enterprises	
Log park	726
Sawmill	101
Kiln & dry	20
Workshop	8 080
Ironmongery	168
Warehouse	528
Showroom	1 974
Subtotal	11 597
Integrated enterprises	
Log park and sawmill	137
Workshop and showroom	78
Workshop and kiln & dry	71
Workshop and log park	37
Workshop and warehouse	15
Other integrated business unit	46
Subtotal	381
Total	11 981

In Jepara 98 % of furniture workshops are classified as small-scale businesses, 1.9 % medium-scale and 0.1 % large scale. Jepara furniture industry uses mostly teak and mahogany. Most workshops, 89.5%, produce indoor furniture; 7.8 % produce outdoor furniture. The remaining workshops produce carvings, handicraft and calligraphy (FVC, 2011). The distribution of business units is shown in Figure 1.
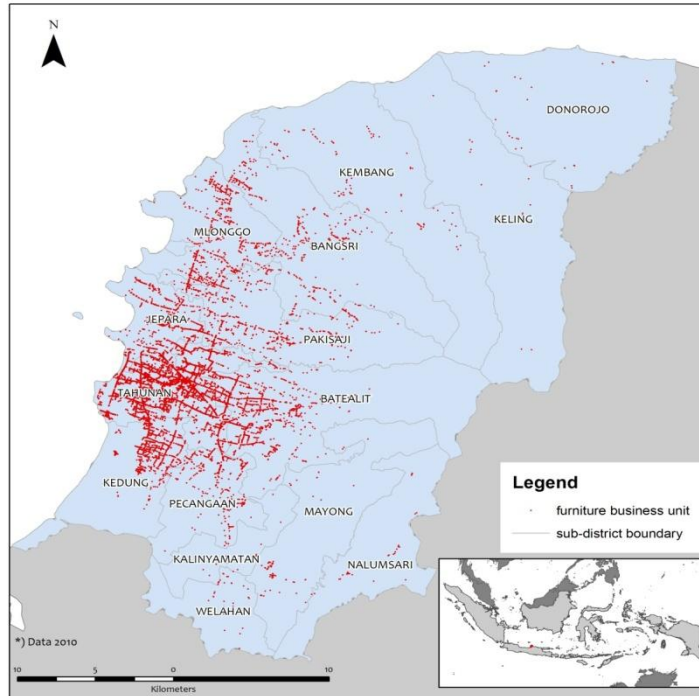
Figure 1. Furniture business unit distribution in Jepara (inset Indonesia)

Small-scale furniture enterprises have established APKJ in the Jepara District. The association was part of a scenario to organize small-scale producers to improve their bargaining power vis a vis financial institutions and markets. Other scenarios designed for small-scale producers were to move up to higher stages of the value chain, collaborate down with wood suppliers and tree growers and implement green certification. Figure 2 shows the various value chains within the furniture industry, where small-scale producers or enterprises are located (Purnomo *et al.* 2011).
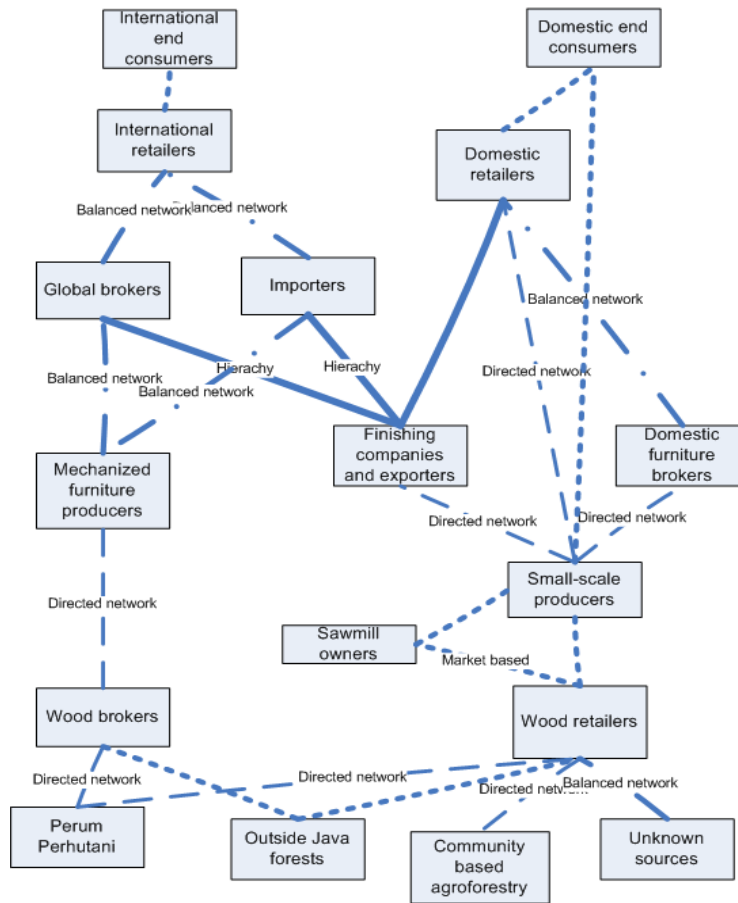
Figure 2. Value chains of furniture industry (Purnomo *et al.* 2011)

The association's vision is to improve small-scale furniture producers' potential to make them more independent and competitive in the global market, and to empower APKJ members for the prosperity and advancement of the Jepara furniture industry. Its mission is to improve small-scale furniture producers' bargaining skills, create fair market prices and facilitate access to credit. The association facilitates collective action and is recognized by the Jepara District Government, wh involves them in the decision-making processes. An indication of this recognition has been the Jepara District Government's invitation for APKJ to attend many of its important meetings and exhibitions. Small-scale producers have used this association to channel their voices in the decision-making process and balance their power vis-à-vis large companies.

2.2. Method

We followed a method suggested by Rogers (2003) to research on innovation diffusion. First, we identified four elements of innovation diffusion i.e. (a) innovation; (b) communication channel; (c) time and (d) social system through surveys and interviews. Second, we constructed the conceptual model of innovation diffusion in the Jepara furniture industry. Third, we made a model of the innovation-diffusion using the agent based modeling (ABM) technique. Fourth, we identified scenarios to speed up the diffusion of innovation.

An innovation is attributed by relative advantage, compatibility, complexity, trial-ability and observability. Relative advantage is the degree to which an innovation is perceived as being better than the previous idea. It is measured by economic profitability, social prestige etc. Compatibility is the degree to which an innovation is perceived as consistent with the existing values, past experiences and needs of adopters. Complexity is the degree to which an innovation is perceived as relatively difficult to understand and use. Trial-ability is the degree to which an innovation may be experimented with on a limited basis. Observability is the degree to which the results on an innovation are visible to others (Rogers 2003).

A channel is the means by which a message gets from the source to the receiver, while 'source' is an individual or an institution that originates a message. Basically there are two kinds of communication channels i.e. mass media and interpersonal channels. Mass media are means of transmitting messages that involve a mass medium, such as television, radio and newspapers. Interpersonal channels involve a face-to-face exchange between two or more individuals. Mass media can rapidly reach a large audience, create knowledge and spread information, and change weakly held attitudes. Interpersonal communication can provide a two-way information exchange and persuade an individual to form or change. Therefore interpersonal channel is especially important in persuading an individual to adopt an innovation (Rogers 2003).

There are four key phases in the development of a model (Grant *et al.* 1997) i.e. (a) Forming a conceptual model is to state the model's objectives, bound the system of interest, categorize its components, identify relationships, and to describe the expected patterns of the model's behavior; (b) Specifying the model is to identify the functional forms of the model's equations, estimate the parameters, and to represent it; (c) Evaluating the model is to re-assess the logic underpinning the model, and compare model predictions with expectations; (d) Using the model is to develop scenarios. In this paper we emphasize the development of a general model of innovation diffusion using ABM.

We implemented the principal component analysis (PCA) in categorizing stakeholders in the context of the furniture industry. PCA is a mathematical procedure that uses an orthogonal transformation to convert a set of observations of possibly correlated stakeholder characteristics into a set of values of linearly uncorrelated variables called principal components. The number of principal components is less than or equal to the number of original variables.

III. RESULTS
3.1. Elements of APKJ Innovation Diffusion
3.1.1. APKJ Innovation attributes

APKJ is an institutional innovation aimed to organize small-scale producers for collective action to improve their bargaining power. APKJ is an association or organization with written rules of the game and activities. Therefore, APKJ is an institution as defined by Ostrom et al. (1999). The APKJ innovation is attributed by relative advantage, compatibility, complexity, trial-ability and observability.

Regarding the relative advantage and observability, APKJ innovation provides better economic outputs to its 120 members. APKJ members have participated in various trade exhibitions and e-marketing through www.javamebel.com. Some APKJ members have created a new business group among the members. Many APKJ members now earn more in 2012 than they did before joining APKJ in 2009. In a recent survey, 78% of APKJ members experienced an increase in sales and income in the past year, while only 44% of non-APKJ member producers claimed to have increased their sales and 40% of their income. The Jepara expo and its follow up produced trade transactions amounting to 50 million rupiah, while PPE (Indonesia's export product expo) provided almost the same amount albeit catering for a wider market. In all trade exhibitions and project works, the internet collective marketing portal of javamebel.com was promoted. APKJ members received economical benefits from the portal and at the same time learned how to satisfy customers from around Indonesia as well as foreign buyers. Buyer satisfaction is the key to the sustainability of the portal. The javamebel.com provided business transactions amounting to about 100 million rupiahs since it was developed. APKJ members received trainings in entrepreneurship, green certification, marketing, finance, management, accounting etc. During the finance training we invited people from Bank Rakyat Indonesia (BRI) to explain how to access credit for small-scale businesses with low interest rates. Some APKJ members were then able to obtain small-scale and sizeable loans from (BRI) ranging from IDR 20 million to 50 million.

Becoming members of APKJ improved their social status. APKJ has been recognized in Jepara, Central Java and Indonesia. In Jepara every policy and regulation formulation processes on furniture exercised by the Jepara government involves APKJ. In Central Java, APKJ was invited by trade and industrial agencies for trainings, workshops and presentations. At the national level, APKJ was invited by the Ministry of Forestry to share its experiences in organizing small-scale producers and improving wood efficiency. Several local actors went overseas among others to India, facilitated by APKJ to present and promote their products.

The APKJ innovation is compatible with cultural values and beliefs of the Jepara people. The people support ideas that enhance livelihoods, development and togetherness of people. Jepara has the Javanese motto i.e. "*Trus Karyo Tataning Bumi*" or continue to work hard to develop the region. APKJ is also compatible with previous ideas such as cooperatives and clusters within the furniture industry. APKJ strengthened the existing ideas and focused on small-scale producers. APKJ was a dream for small-scale producers, who longed to have their own association instead of ASMINDO (Furniture Industry and Handicraft Association), which

was dominated by large players andhad different problems, challenges and opportunities from them.

The APKJ innovation is simple. Small-scale producers could simply come to the APKJ office which is located at the Jepara Trade and Tourism Center (JTTC) to join the association. An annual membership fee on $10 is payable upon joining APKJ. Once registered,, members have to obey APKJ's rules. APKJ is also a place to share and exchange information. Members would be prioritized to participate in trade exhibitions, trainings, workshops etc.

The APKJ innovation was thing that people could try. Before joining APKJ they could be a friend of APKJ and they could participate in APKJ activities. This trial-ability is aimed to slowly introduce those who are unfamiliar with a modern organization like APKJ. However, after joining APKJ anyone could withdraw their membership without difficulty, as joining is a rational choice.

3.1.2. Communication Channel

The existence of APKJ was communicated through mass media, interpersonal channels and CIFOR'sfurniture value chain--(FVC) project. The mass media comprised of websites, marketing portals, radio, bulletins and newspapers. The website http://aspekaje.blogspot.com/2012/01/ksu-apkj.html provided a brief description of APKJ as an organization and its activities in Indonesian language. APKJ developed its marketing portal at http://www.javamebel.com/ which developed an online gallery showcasing small-scale producer products. The portal's content is all written in Indonesian. APKJ activities were also communicated through the FVC project website at http://www.cifor.org/furniture, which is written in English. Many times APKJ's activites were communicated through interactive dialogues on Radio Swara Jepara, which has listeners across Jepara. APKJ also distributed its simple bulletin named 'APKJ Bulletin' to disseminate their events and activities to members. Coverage of APKJ's activities also occured sereval timesby newspapers and magazines siuch as Jawa Pos, Nova and Gatra. This included the coverage of the industry roadmap process, furniture shopping and tourism map, the book of *Menunggang Badai* (Storm Riding) and *Pelangi di Tanah Kartini* (Rainbow in Kartini's Land).

Interpersonal channels were built upon by APKJ's board and members through face-to-face communication. The FVC project team regularly met their local facilitators. APKJ has various meetings, workshops and trainings as fora for them to share and exchange information. APKJ members participated in many meetings and workshops organized by the Jepara District Government and its units as well as other organizations at local, provincial and national levels.

3.1.3. Time

The idea of establishing an association for furniture producers and SMEs existed since 2005. Since then the idea of APKJ was diffused and known by people of Jepara. APKJ was finally established in 2009. Throughout time, APKJ members have increased although not

dramatically. In the model, we selected 'year' as a time step. We then projected the number of APKJ members for the next 20 years.

3.1.4. Social System

Jepara District covers an area of 100.413 ha, comprised of 16 sub-districts across 194 villages. The population of Jepara is 1,073, 631, with 50.32% male and 49,68% female (BPS 2008). Mlonggo is the most populous sub-district (11.87%), and Karimunjawa is the least (0.80%). The population density is 1,069 people/km2, with Jepara sub-district being the highest (3.039 people/km2), and Karimunjawa the least (120 people/km2) as shown in Figure 3. The population consists of productive ages (15-64 year) 66.10%, under 15 year 29.19% and above 65 year 4.70%. Jepara is a furniture district. Various stakeholders or actors are involved in value creation and addition.
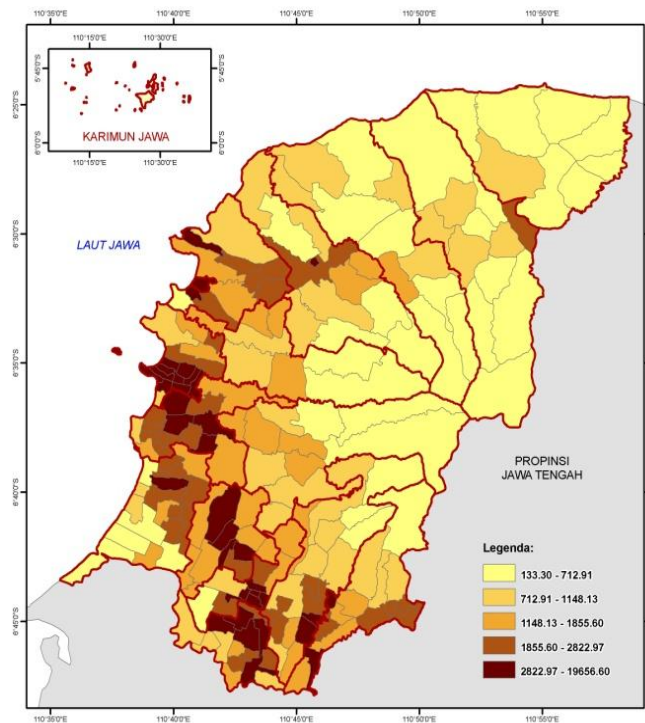

Figure 3. Population density of Jepara

Many stakeholders are involved in the Jepara furniture value chain (Figure 2). Annex 1 provides a list of stakeholders and their abbreviations. These stakeholders can be located in a two dimension diagram by applying PCA in Figure 4, which indicates the strength and profile of each stakeholders in terms of i.e. having their livelihoods dependent on the furniture industry, having a degree of power in the furniture business, having a degree of power in the policy making processes (e.g. bureaucracy/ governmental administrative system), having political power (e.g. political parties, allies) and knowledge on furniture. The private sector and small scale and medium scale associations i.e. APKJ (Jepara Furniture Small-scale Producer

9

Association), HPKJ (Jepara Wood Trader Association) and ASEPHI (Handicraft Producer and Exporter Association) are relatively in the same group. They are reliant on the furniture industry ; having high livelihood dependency as well as having strong knowledge on wooden furniture and craft industry. ASMINDO as the large scale furniture producers association is somehow dependent as well on the industry but at the same time having a strategic position in accessing business and politics. Another private sector which has access to business and political power is KADIN (Chamber of Commerce and Industry), which interestingly is less dependent on the furniture business. Furniture is one of KADIN's interests but not the only one. Clearly Government bodies such as the Bupati (Head of district) Office, District Parliament and a state owned company PERHUTANI are standing in the same polar, where they have power in business, power in politics as well as power in policy making. Especially to PERHUTANI, its power in business and policy making is more on the raw material, e.g. defining their wood price. PERHUTANI is a state owned forest enterprise that supplies the high quality wood, mainly teak to the furniture industry. Their role in defining raw material price is very significant in influencing furniture industry in general.
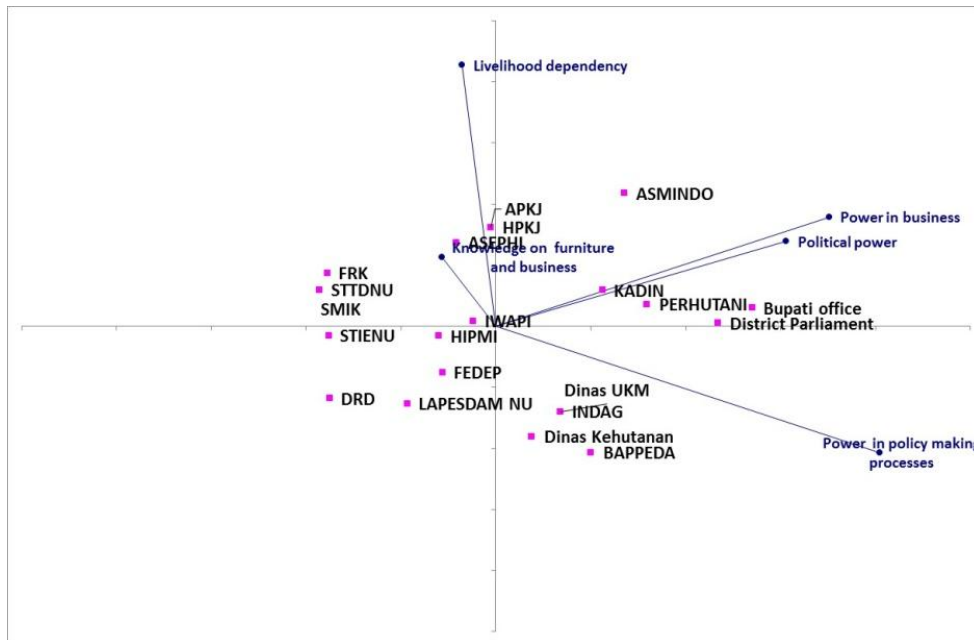

Figure 4. Principal Component Analysis of Jepara stakeholders

Other government bodies, i.e. *Dinas UKM (SME's agency) INDAG (trade and industry agency)*, *Dinas Kehutanan* (Forestry agency) and BAPPEDA (District Development Planning Agency) stand in slightly different corners as part of the Bupati Office. They are authorized to make policy but are less powerful than the Bupati and do not necessarily have access to political power. Some educational bodies oppose the politics and business power corner. FRK, STDNU, SMIK and STIENU have knowledge on the furniture industry but they are less dependent to the

furniture business are as HPKJ, APKJ and ASEPHI. The remaining stakeholders are LAKPESDAM NU (Human Resources Research and Development Agency of *Nahdatul Ulama*), FEDEP (Forum for Economic Development and Employment Promotion) and DRD (District Research Council) who do not rely their livelihoods on furniture and do not have access to power in business as well as policy. HIPMI (Indonesian Young Entrepreneurs Association) and IWAPI (Indonesian Women Entrepreneur Association) are less significant players but they have power in business and knowledge in the furniture industry.

All stakeholders are scattered into different clusters and have different levels of access, power and knowledge. Therefore, in a multi-stakeholder negotiation process, each stakeholder has s different niche and significance.

3.2. Diffusion of APKJ innovation among people in Jepara

In the context of innovation diffusion, we characterize people into five categories as described in Table 2. APKJ now has been adopted and become a recognized organization in Jepara. Here we identify change agents as the local facilitators of the FVC project.

Table 2. Categories of the adopters

	Innovators	Early adopters	Early majority	Late majority	Laggards
Main characteristics	Venturesome	Respect	Deliberate	Skeptical	Traditional
Type of communication channel Influence them	Mass media	Interpersonal	Interpersonal	Interpersonal	Interpersonal
Number of people	Few	Quite many	Many	Many	Few
When/year	2005	2008	2009	2010-2012	2013 up
Individual adopters	Two people	15 APKJ board members	60 people of early APKJ members	75 people of additional APKJ members	-
Institutional adopters	None	Groups of small-scale producers, UKM, ASEPHI	BAPPEDA, INDAG, ASMINDO	KADIN, Dinas Kehutanan, PERHUTANI	National government agencies

Initially five small-scale furniture producers and carvers--or innovators--thought they needed to have an association of small-scale producers in 2005 before APKJ existed. They consulted various organizations--both government and non-government--to support this idea. However, none of them seriously considered and supported this idea. Throughout time, three of them withdraw from this idea, leaving two innovators struggling by their own. Then in 2008, a workshop was conducted by the FVC team in Jepara where the association idea was supported by workshop participants. The idea matured by the end of 2008 and became respected by others. APKJ was thus declared in 2009 and conducted bi-weeklymeetings. At that time, APKJ was supported by small-scale producers, Jepara government cooperative unit (Dinas UKM) and ASEPHI. They were the early adopters of the APKJ innovation.

In 2009, 60 small-scale producers had joined APKJ. BAPPEDA, ASMINDO and INDAG at the same time started to comprehend and value APKJ's existence. They became the first majority who adopted the APKJ innovation. During 2010-2012, 75 people adopted this institutional innovation. They adopted the innovation after participating in trainings hosted by APKJ in collaboration with other organizations such as IWAPI and BAPPEDA. The interest of joining APKJ also attracted small-scale producers from outside Jepara District i.e. Blora and Yogyakarta. They became the late majority.

We found that those who were characteristically similarto APKJ in PCA results tended to adopt earlier than those who were not. This was proven by how fast HPKJ and ASEPHI adopted the APKJ innovation sinceshared the same characteristics of a small-scale association. Meanwhile, ASMINDO adopted the innovation later on than ASEPHI since they were mostly supported by large enterprises.

3.3. Early efforts for Spatially Explicit Agent-Based Model of Innovation Diffusion

The conceptual model comprises four elements of innovation diffusion i.e. APKJ innovation, communication channels i.e. interpersonal communication and mass media, time and social system, which comprise of innovators, early adopters, early majority, late majority and laggards that are embedded in the spatial system of Jepara (Figure 5). Change agents communicate the APKJ innovation to people who are identified as innovators and the mass media. Innovators accept the innovation and may seek to modify it. Innovators then communicate the innovation to other people who are later identified as early adopters, who also communicate to people characterized as early majority of adopters. The late majority of adopters are influenced by the early majority. Finally, in the end laggards also adopt the innovation.
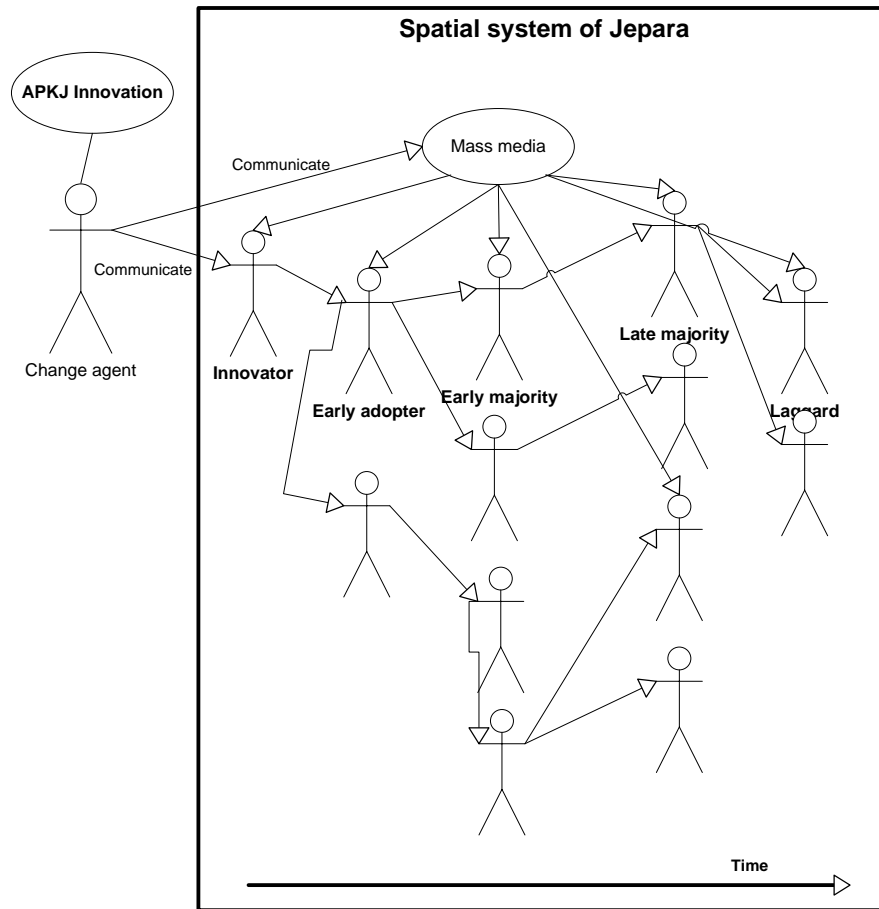
Figure 5. Conceptual diagram of the APKJ innovation diffusion

Change agents communicate the APKJ innovation through the mass media. The radio *Swara Jepara* frequently mentions APKJ as an organization for small-scale producers. APKJ was also communicated through newsletters and bulletins published by APKJ management. Provincial newspapers quoted APKJ activities.

The conceptual model was implemented in a ABM model. As mentioned earlier the innovation is defined as an institutional innovation, which is APKJ (*Asosiasi Pengrajin Kecil Jepara*), an association of small-scale furniture enterprises in Jepara, established in 2009. The adoption targets small-scale furniture enterprises in Jepara, and so called agents. Adopter agents are APKJ members. According to Rogers (2003), agents are classified based on their adoption time: (i) innovators; (ii) early adopters; (iii) early majority; (iv) late majority; and (v) laggards. Moreover, each type of agent is attributed based on their population, learning capacity, and characteristics in direct and indirect communications (i.e. through media), as described in Table 3.

The conceptual model was implemented in ABM model. As we mentioned earlier the innovation is defined as institutional innovation, which is APKJ (*Asosiasi Pengrajin Kecil Jepara*), an association of small-scale furniture enterprises in Jepara, established in 2009.

13

Adoption target is small-scale furniture enterprises in Jepara, and so called agents. Adopter agents are APKJ members. Agents are classified based on their adoption time according to Rogers (2003) into 5 types: (i) innovators; (ii) early adopters; (iii) early majority; (iv) late majority; and (v) laggards. This classification is made based on timeseries of adoption, which is logistic function (or also called as sigmoid function), forming a pattern of S-curve (Figure 6). The first derivative of this curve is Gaussian bell shaped, indicating successive adoption, from which Rogers (2003) classified agents into 5 types of adopters as stated above (Figure 7).
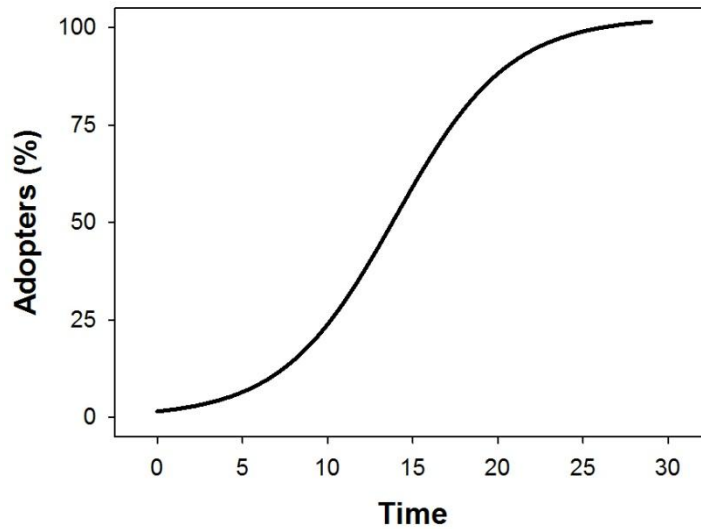

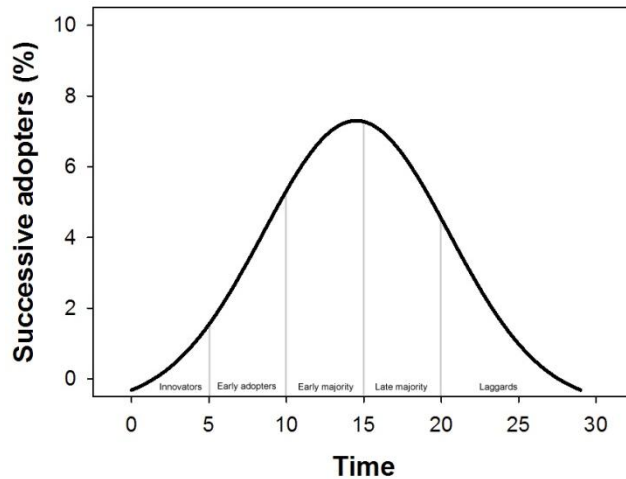Figure 6. Adoption according to Rogers (2003)

Figure 7. Adopters typology according to Rogers (2003), based on successive adoption.
Thus, based on Rogers' S-shaped adoption curve as shown in Figure 6 and Rogers' classification on type of adoption agents as shown in Figure 7, we can break down S-shaped adoption curve as shown in Figure 6 into 5 smaller S-shaped adoption curves of each type of adoption agents (Figure 8A). Transforming 5 S-shaped curves as shown in Figure 8A into agent share to overall adoption with respect to time of adoption, we have adopters composition by agent type (Figure

14

8B). Please, notice that time lag between two consecutive tipping points of each type of adoption agents as shown in Figure 8B indicate Rogers' strong assumption in classifying agents of adoption into 5 types based on time of adoption. It is obviously shown by the figure that tipping points of successors should take place after particular time interval from tipping points of their predecessors, e.g. tipping point of early adopters emerged after about 4 years from tipping point of innovators, and so on.

Furthermore, the model is developed as spatially explicit agent-based. Thus, at first, we should explore, whether Rogers classification on adoption agents based on agents' behaviors in time has incorporated their behaviors in space, e.g. whether early adopter type of agents will adopt the innovation earlier than early majority type of agents, regardless their behaviors in space and heir neighborhood. For this purpose, agent share as shown in Figure 8B will be used as indicator.
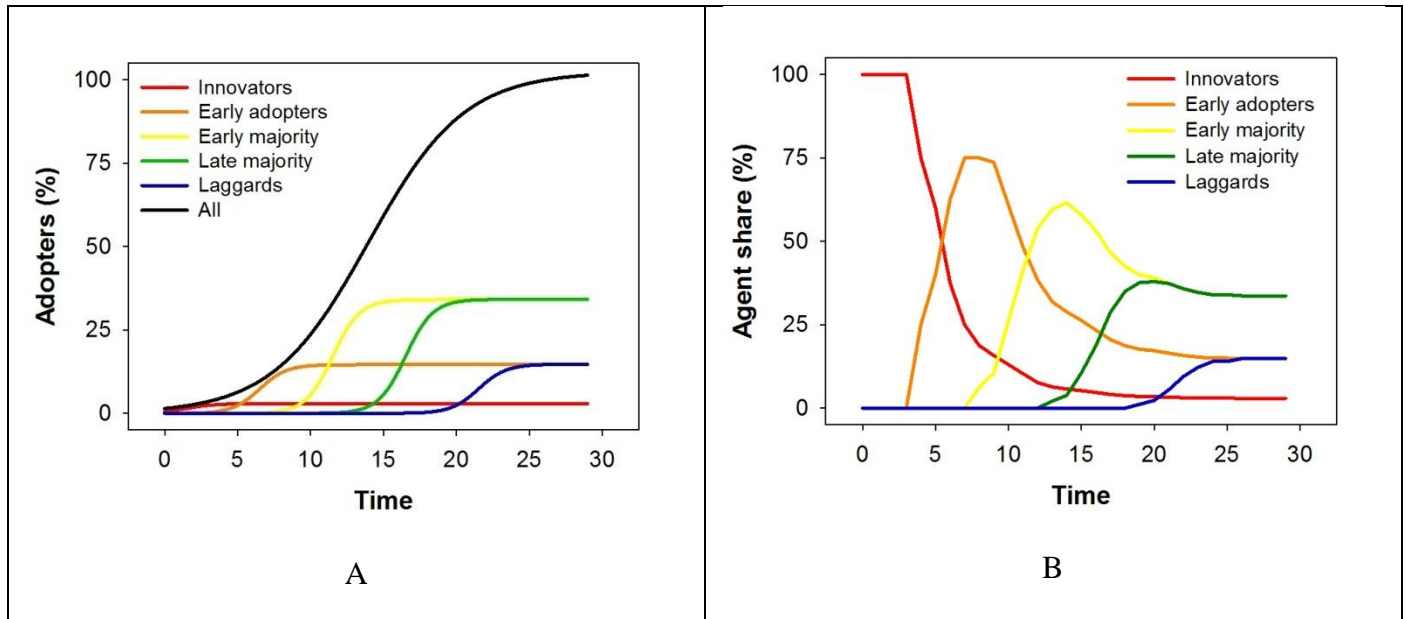

Figure 8. Adoption by each type of agent (A) and share of each agent to overall adoption (B).

Moreover, each type of agent is attributed based on their population, learning capacity, and characteristics in direct and indirect communications (i.e. through media), as described in Table 3. The default values of population fraction of each agent is made based on Rogers' successive adoption curve (Rogers, 2003).

Table 3. Agent types and attributes

Agent attributes	Dimension	Agent types				
		Innovators	Early adopters	Early majority	Late majority	Laggards
Population fraction.	Dimensionless parameter, ranging from 0 to 1.	Very low Default= 0.02	Medium Default=0.135	Very high Default=0.34	Very high Default=0.34	Low Default= 0.16
Maximum distance range of partners in direct communication networks, relative to maximum distance of the landscape.	Dimensionless parameter, ranging from 0 (very close) to 1 (very far).	Very far Default= 1	Very far Default=1	Medium Default=0.5	Close Default=0.25	Very close Default= 0.1
Maximum number of partners in direct communication networks.	Unit: partners.	Very high Default= 10	Very high Default=10	Low Default=3	Very low Default=1	Very low Default= 1
Peference to choose information sources as partners in direct communication networks.	Dimensionless parameter, ranging from 0 (very low) to 1 (very high).	Very high Default= 1	Very high Default=1	Low Default=0.125	Very low Default=0.01	Very low Default= 0
Flexibility to change partners in direct communication networks.	Dimensionless parameter, ranging from 0 (very low) to 1 (very high).	Very high Default= 1	Very high Default=1	High Default=0.75	Very low Default=0.05	Very low Default= 0.01
Willingness to share information with their partners in direct communication networks.	Dimensionless parameter, ranging from 0 (very low) to 1 (very high).	Very high Default= 1	High Default=1	Medium Default=0.75	Low Default=0.15	Very low Default= 0.01
Trust to information obtained from direct	Dimensionless parameter, ranging from 0 (no low) to	Very high Default=	High Default=1	Medium Default=0.125	Low Default=0.05	Very low Default= 0.01

Agent attributes	Dimension	Agent types				
		Innovators	Early adopters	Early majority	Late majority	Laggards
communication.	1 (very high).	1				
Ability to understand information obtained from media.	Dimensionless parameter, ranging from 0 (very low) to 1 (very high).	Very high Default=1	Very high Default=1	Medium Default=0.5	Low Default=0.25	Very low Default=0.1
Trust to information obtained from media.	Dimensionless parameter, ranging from 0 (very low) to 1 (very high).	Very high Default=1	Very high Default=1	Low Default=0.125	Very low Default=0.05	Very low Default=0.001

Since information on innovation is communicated indirectly through the mass media, media reach is used as an indicator to simulate its effectiveness. Media reach is defined as a number of agents exposed to media, expressed as a fraction from the total population, ranging from 0 (no media reach) to 1 (media reach covers all agents). Information on innovation is obtained by each agent either through direct communications or media, which will change the willingness of each agent to adopt the innovation. Willingness of agents to adopt innovation is scored from 0 (not interested to adopt) to 1 (very interested to adopt). In the model, this parameter is used as probability to adopt. Thus, closer the value to 1, probability of agents to adopt the innovation increases. Moreover, willingness to adopt is formulated as follows:

$$p_t = p_{t-1} + \beta\left(\frac{\sum_{i=t-1}^{i=t-m-1} i1_i}{m} - p_{t-1} + \alpha\left(\frac{\sum_{i=t-1}^{i=t-m-1} i1_i}{m} - p_{t-1}\right)\right)$$
$$+ \alpha\left(\frac{\sum_{i=t-1}^{i=t-m-1} i2_i}{m} - p_{t-1}\right)$$

Where:
α = trust to information obtained from media, ranging from 0 (not trust at all) to 1 (perfectly trust),
β = trust to information obtained from direct communication with others, ranging from 0 (not trust at all) to 1 (perfectly trust),
i1 = information obtained from partners in direct communication, scored according to level of understanding the information, ranging from 0 (not understand at all) to 1 (perfectly understand),

i2 = information obtained from media, scored according to level of understanding the information, ranging from 0 (not understand at all) to 1 (perfectly understand),
m = deliberation degree on historical information (years),
p = willingness to adopt, scored from 0 (not interested to adopt) to 1 (very interested to adopt),
t = current time of simulation (year).

Strong assumption used in the current version of this model is that once agents adopt the innovation, they will never drop it. Thus, no benefit learning process by agents has been incorporated in the model. The model was tested using Jepara landscape, derived from the map of small and medium scale producers of Jepara at a very coarse spatial resolution of 9 km^2. Agents attributes are assigned randomly during initialization. Thus, innovators might have laggards type of neighbors, but might also have direct communication with other types of adopters, and so on.

The Model behavior was evaluated by media reach of 0%, 50%, and 100% of total population. To avoid 'bias', agents that are exposed to media are randomized during initialization only. The model was run using 100 replicates for each 'evaluation scenario' using avsimulation duration of 20 years. Simulated patterns of agent share to overall adoption at media reach of 0%, 50% and 100% are shown in Figure 9. All patterns behave unexpectedly compared to the expected pattern of agent share to overall adoption as shown in Figure 8B. At media reach of 0%, tipping points of early adopters and early majority were overlapping with a too close time lag from tipping point of innovators (only 2 years), time lag of tipping point of late majority to tipping point of early majority was also too close (only 1 year), and only time lag of tipping point of laggards to tipping point of late majority was in expected range (4 years). At media reach of 50% and 100%, tipping points of early adopters, early majority and late majority were overlapping with a too close time lag from tipping point of innovators (only 1 year). At media reach of 50%, time lag of tipping point of laggards to tipping point of late majority was still in expected range (5 years), but it shifted to unexpected range (only 1 year) at media reach of 100% These results suggest that attempts to classify agents of a spatially explicit agent-based model into typology of adopters as developed by Rogers (2003) is improper. It is very obvious since Rogers developed such typology with respect to agents behavior in time, without specifying their characteristics in space. Thus, Rogers' typology of adopters should be used to classify simulation results on adoption, not for stratifying agents as such. For instance, we can further analyze the simulation results, and use it to explore which attributes of agents that actually determine their time of adoption. It is very possible that agents with conservative way of learning that we assume will adopt the innovation very late, will actually adopt the innovation earlier if they actually are exposed intensively to information about the innovation. On the contrary, it is also very possible that agents with progressive way of learning that we assume will adopt the innovation very early, will actually adopt the innovation later if they actually are not exposed intensively to information about the innovation.

Regardless the inconsistency of agent typology used by the model that attempted to classify agents based on Rogers (2003), the model behave properly in term of its simulated adoption patterns at aggregate level, i.e. simulated adoption patterns were S-curve shaped

(Figure 9) and simulated successive adoption patterns were Gaussian shaped (Figure 10). In this case, effects of media reach determined skewness of the curves.
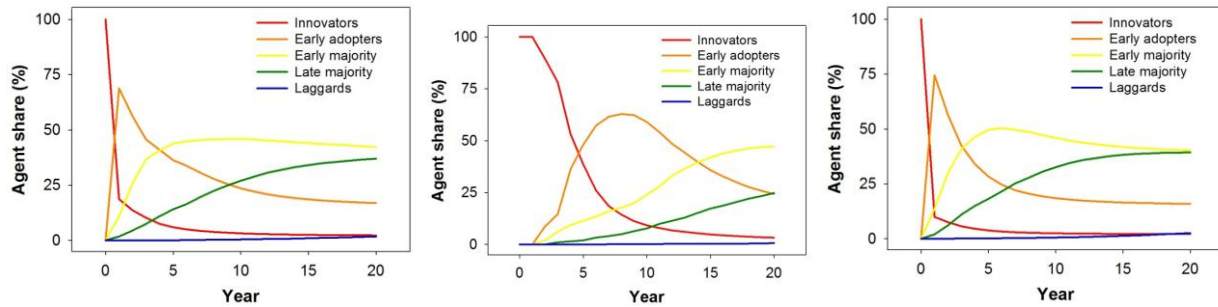

Figure 9. Share of each agent to overall adoption at media reach of 0%, 50% and 100%.
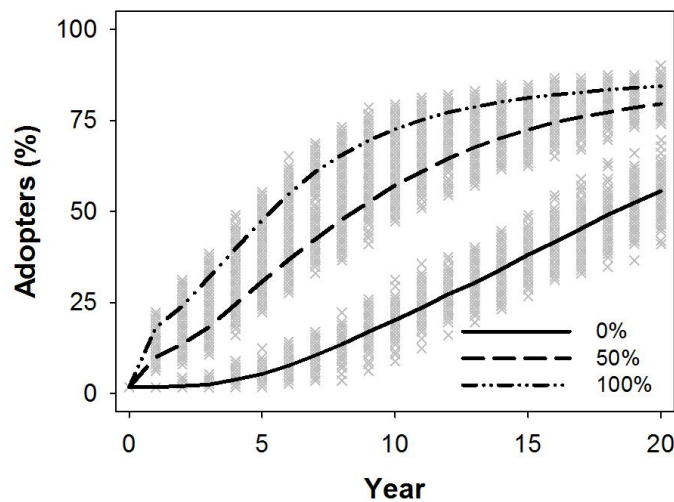

Figure 10. Effect of media reach on number of adopters for 20 years. Grey crosses are simulated results from all 'evaluation scenarios'. Lines are average of 100 runs from each 'evaluation scenario'.

Figure 11 provides effect of media reach on number of successive adopters for 20 years. Grey crosses are simulated results from all 'evaluation scenarios'. Lines are average of 100 runs from each 'evaluation scenario'. Notice that sum of number of successive adopters from year 0 to year 20 as shown in this figure resulted number of adopters as shown in Figure 10, since number of successive adopters as shown in this figure is the first derivative of (dy/dx) of Figure 10.
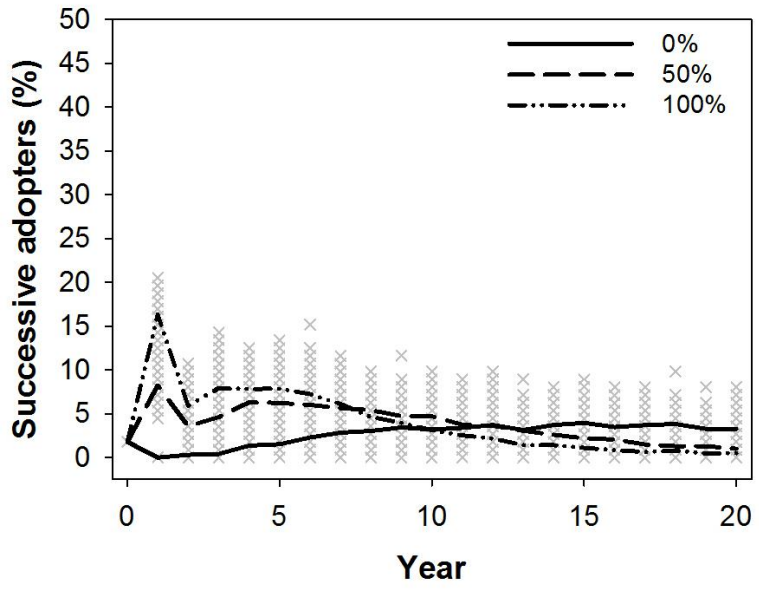
Figure 11. Effect of media reach on number of successive adopters for 20 years.

Figure 12 shows the dynamics of simulated innovation diffusion in space at media reach of 50%. It is obvious that patterns of innovation diffusion in space are not only determined by visible factors, such as neighborhood effect; but also by some invisible factors, such as direct communication networks and agents characteristics on learning.

Year 0

Year 1

Year 2

Year 3

Year 4
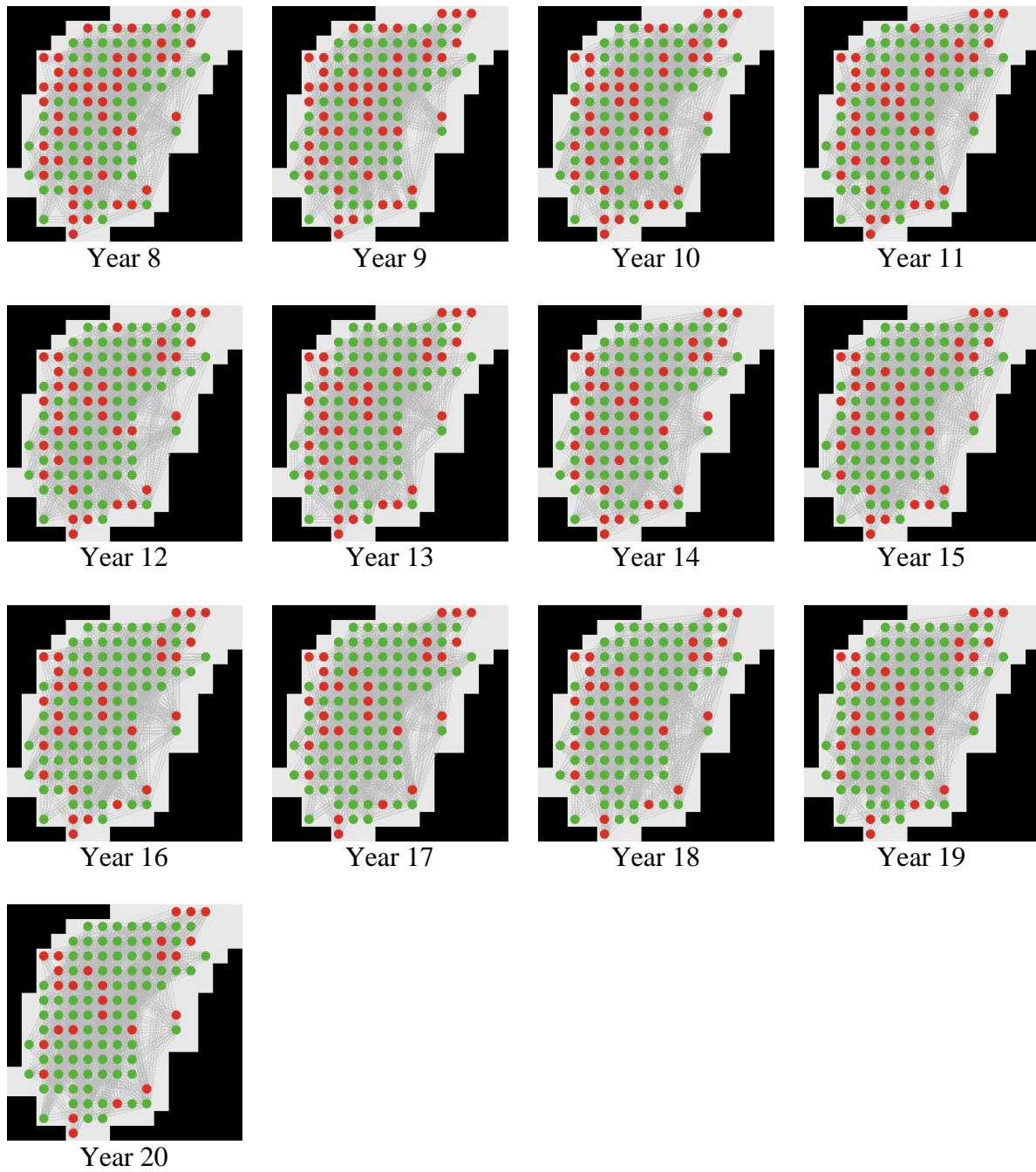

Year 5

Year 6

Year 7
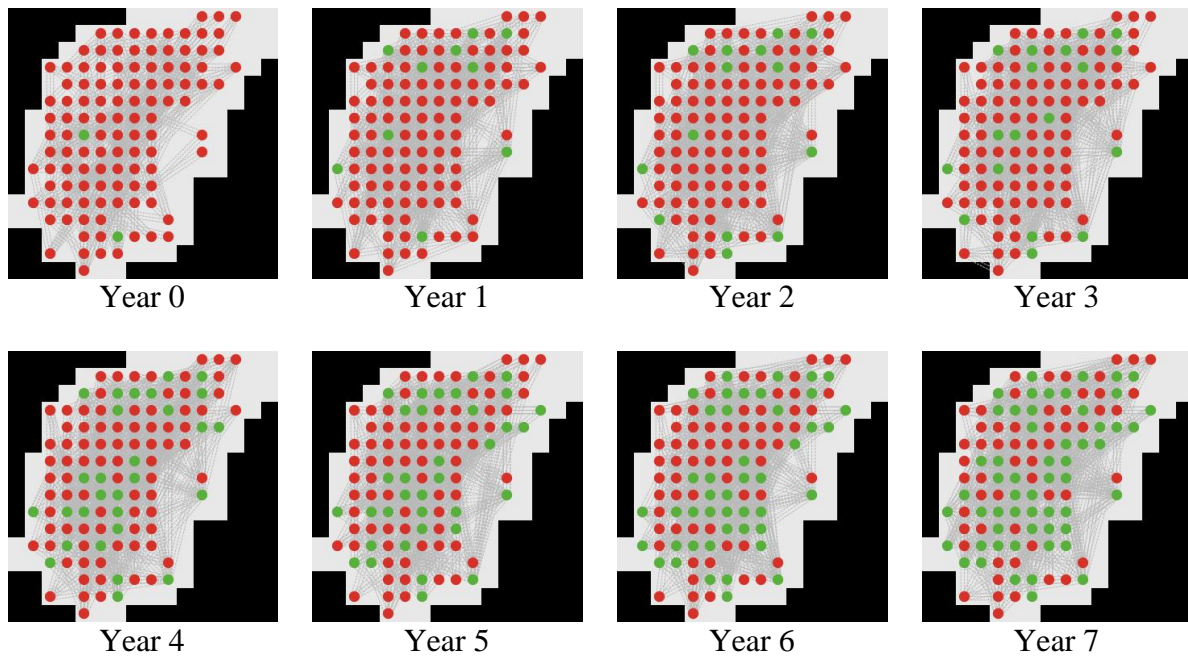
Figure 12. Simulation results from 1 replicate at media reach of 50%. Green agents are adopters. Red agents are non adopters. Grey lines are direct communication networks among agents. Dynamics of direct communication networks in every time step (yearly) are caused by flexibility of some agents to change their partners.

IV. DISCUSSION

The method proposed by Rogers (2003) was applicable in the context of the Jepara furniture industry. We can observe how the APKJ institutional innovation diffused among various stakeholders in Jepara and beyond. Elements of innovation diffusion which cover innovation, communication channels, social systems and time can be well defined in the context of APKJ. The attributes of the APKJ innovation which include relative advantage, compatibility, complexity, trial-ability and observability can also be clearly defined.

The ABM method was also able to project the number of adopters in the next 20 years through different media reach.   The ABM is able to model how individual actors perceive the innovation and then chooses to either accept or reject it. Clearly from this simulation, having greater media reach will enhance the adoption of APKJ. This was the challenge. The member of APKJ has grown since the beginning of its establishment.However, APKJ members are relatively smaller than the total 11,981 business units of workshops in Jepara.

The method has shown how innovation is diffused and adopted by small-scale furniture producers in Jepara. It involves key actors such as change agents, innovators, early adopters, majority of adopters, late adopters and laggards. In real life, the situation is much more complex. There are people who are always against new ideas and strives to keep the system going in the opposite direction. There are also stakeholders who are not as active as the innovators but inspires change agents and innovators. These actors are respectively identified as reactionaries and spiritual recluses (AtKisson, 1996). The inclusion of other actors apart from the adopters adds to the dynamic of the diffusion of innovation. It involves change agents to accurately identify who are friends and foes. Reactionaries might busy the innovators if they are not controlled well.   Strategies are needed to succeed in the situation where the interest of stakeholderss are not quite clear.

The entire process of APKJ's innovation diffusion is explainable along the innovation decision model as described by Rogers (2003) and shown in Figure 9. Jepara furniture stakeholders perceived the innovation and made the decision on whether or not to join APKJ. During its tenure, most stakeholders were committed to be part of APKJ, although a few of them were not active. The adoption of this innovation is quite smooth because the innovation was demand driven, particularly by SMEs.   Channels from both mass media and personal connections played an important role in this adoption.
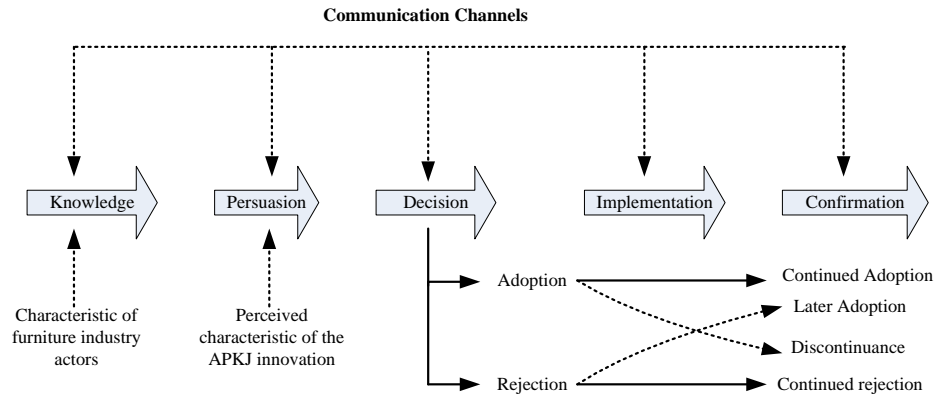
Figure 9. Innovation decision process model (After Rogers, 2003)

The APKJ innovation became a common property. However, there is minimum requirement to enable its access. Those who could not access the APKJ innovation were either restricted by physical (remotely located) or non-physical distances e.g. political conflict, women group, lack of information and non-targeted users (LEs). Several women groups cannot access the innovation due to time limitation for women to join APKJ. Women times are wholly occupied by their activities to provide food and education for their children. Therefore, they have no time to try something new.

We also argue that the final result of the APKJ innovation is unpredictable, as underlined by the complexity theory. Complexity theory engages the tempting idea that understanding the link between a transformed 'whole' and its original constituent parts is difficult to make (Purnomo 2012). The social world is a complex system in which multi-dimensions, adaptability and non-linearity are the main characteristics. Jepara political processes, such as Bupati and parliament elections resulting new Bupati and parliament members, add complexity to the model so that the model behavior is unexplainable.   Moreover, the phenomena of pseudo adopters (Kiptop *et al.* 2007) may emerge when the project ends in 2013. The pseudo adopters adopt APKJ innovation as long as the project exists and they get direct benefit or payment from it, but will leave it when the project ends.

In the future, the APKJ innovation should be strengthened. At the moment the capacity of APKJ members are relatively low in terms of organizational skills. However, the number of existing members are considered enough to run daily operation and organization programs. Whereas in a modern organization, people move by incentives so that membership will grow as the benefit grows. APKJ in the future should offer various benefits such as protection for small-scale producers in terms of dealing with external parties such as large companies or policy makers. The association also needs to keep their constituents informed about the market situation, policies as well as product design and innovation (Sutrisno, pers.comm.).

Benefits of joining the association may not be completely realized by every producer, instead they need to experience it in a real situation or practical program. One of the suggestions made by members of APKJ was to establish a cooperative as a way to form economic force and improve communication channels, functioning to promote products and as a platform for producers to have face to face interaction (Tohir Diman and Yoyok, pers.comm).

Further development of a cooperative may include programs such as improving marketing techniques, strategy and innovation, whichwill lead to an increase of income. In the future, APKJ needs to visit each production center and cluster in Jepara in order to expand its network and membership. Those who can join can be assessed by looking at the eminent persons in a particular area so he/she can embrace other producers in the same cluster; and the spirit of innovation initiated by small groups regardless of their location.

APKJ could learn from the cooperative which has been developed by its members (i.e in Mulyoharjo by Suryadi) on how they operate, the management system and its organization. As a legalbody recognized by the government,APKJ should function their cooperative channels to enhance marketing and promotion, and as a source of capital for its members.

In relation to marketing techniques, APKJ members might want to consider changing the style of their productsto produce new designs for new (undefined/undimensioned) markets. Why start from products? Because this is what buyers initially see. Changing styles can be applied by developing new designs or improving old ones (i.e vintage designs which are not sold anymore in Jepara) to become more modern. Iimprovements can be done by enhancing product quality and applying appropriate techniques throughout the production process. Meanwhile, new products for undefined markets can be initiated with the eco-labeled furniture produced by small scale producers. This program has been prepared and implemented for small scale producers in which APKJ is also involved in. Once preparations are completed , participating members in this certification program can start developing new product designs targeting a new market with premium price.

Everything can be marketed. Therefore, once improved design-wise, Jepara furniture, with a strong cultural background and good qualitycan definitely become marketed also. APKJ as an organization, with its cooperative can also be functioned as a "one stop showroom" for all Jepara products. Surely it will need good coordination amongst all members, but this is not something impossible to do. Jepara has many kinds of furniture products, made from various species of wood and produced by many small-scale producers. If APKJ can play the role of centrally showcasing Jepara's products, and function as the seller for many small-scale producers, the diffusion and innovation of APKJ's work would spread even wider all around Jepara.

V. CONCLUSION

The APKJ innovation diffuses to various actors within the Jepara furniture industry. APKJ innovation is attributed by relative advantage, compatibility, complexity, trialability and observability. Regarding to this innovation, actors are categorized as innovators, early adopters, early majority, late majority and laggards. A spatially explicit ABM simulated the diffusion of APKJ innovation and S-curve. The theory of complexity as well ABM and PCA were useful in understanding common property.

ACKNOWLEDGEMENTS

REFERENCES

Achdiawan R, Puntodewo A. 2011. *Livelihood of Furniture Producers in Jepara*. Furniture value chain project annual report 2011. Bogor: Center for International Forestry Research.

AtKisson A. 1996. The Innovation Diffusion Game A tool for encouraging participation in positive cultural change -or for doing something different at your next party, http://www.context.org/iclib/ic28/atkisson/

Colfer, C.J.P. 2005. The Complex Forest: Communities, Uncertainty, and Adaptive Collaborative Management. Washington, DC: Resources for the Future and CIFOR.

COMTRADE. 2007. *United Nations Commodity Trade Statistics Database*. New York, UN. Available at:http://comtrade.un.org/db/mr/daCommoditiesResults.aspx?px=S3&cc=8215

CSIL. 2008. *World Furniture Outlook 2008. 8th edition*. Milan, Italy, Centre for Industrial Studies.

Ewasechko, A. C. 2005. *Upgrading the Central Java Wood Furniture Industry: A Value-Chain Approach*. Manila, ILO.

Grant JW, Pedersen EK, Marin SL (1997) Ecology and natural resource management: system analysis and simulation. Addison-Wesley, Reading

Habermas, J. 1987. *The theory of communicative action. Volume 1: Reason and the rationalization of society*. Translated by T. McCarthy. Cambridge: Polity Press.

Han, X., Wen, Y., Kant, 2009. **The** global competitiveness of the Chinese wooden furniture industry. *Forest Policy and Economics*, Volume 11, Issue 8, December 2009, Pages 561-569

ITTO. 2006. International Timber Trade Organization. *Tropical Timber Market Report* 11(15). ITTO.

Janssen MA, Ostrom E (2005) Governing social-ecological systems, handbook of computational economics II: agent-based computational economics, Edited by K.L. Judd and L. Tesfatsion, Elsevier Publisher

Kiptot E, Hebinck P, Franzel S, Richards P. 2007. Adopters, testers or pseudo-adopters? Dynamics of the use of improved tree fallows by farmers in western Kenya. Agricultural Systems (94): 509–519

Kusumanto, T., E.L. Yuliani, P. Macoun, Y. Indriatmoko, H. Adnan. 2005. Learning to Adapt: Managing Forests Together in Indonesia. Bogor, Indonesia: CIFOR.

Ostrom E, Burger J, Field CB, Norgaard RB, Policansky D (1999) Revisiting the commons: local lessons,
global challenges. Science 284(5412):278–282

Purnomo H. 2012. Pemodelan dan Simulasi untuk Pengelolaan Adaptif Sumber Daya Alam dan Lingkungan. Bogor: IPB Press. 312p.

Purnomo H, Guizol P (2006) Simulating forest plantation co-management with multi-agent-system. Math Comput Model 44:535–552

Purnomo H, Guizol P, Muhtaman DR. 2009. Governing the teak furniture business: A global value chain system dynamic modeling approach, Environmental and Modeling Software. *Environmental modelling and software*, 24 (12): 1391-1401.

Purnomo H, Irawati RH, Wulandari R. 2011. Kesiapan Produsen Mebel di Jepara dalam Menghadapi Sertifikasi Ekolabel. Jurnal Manajemen Hutan Tropika Vol. XVII(3): 127–134.

Purnomo H, Irawati RH. Fauzan AU. Melati. 2011. Scenario-based Actions to Upgrade Small-scale Furniture Producers and their Impacts on Women in Central Java, Indonesia *Journal of International Forestry Review. Vol.13(2): 152-162*

Rogers EM. 2003. Diffusion of Innovations. 5th Edition. New York: Free Press. 550p.

Selener, D. 1997. Participatory action research and social change. Cornell University, Ithaca, NY, USA: Cornell Participatory Action Research Network.

Annex 1. Stakeholders of Jepara furniture industry

No	Institution	Abbreviation	Role	Type
1	BAPPEDA	Regional Planning and Development Board	Coordinate district plan development	Government
2	KADIN	Chamber of Commerce and Industry	Coordinate business and commerce activities	Private sectors
3	ASMINDO	Furniture Industry and Handicraft Association	Synchronize furniture business	Private sectors
4	FEDEP	Forum for Economic Development and Employment Promotion	Forum discussion of economic development	Multi-stakeholder forum
5	HIPMI	Indonesian Young Entrepreneurs Association	Associate youth entrepreneurs	Private sectors
6	APKJ	Jepara Furniture Small-scale Producer Association	Associate small-scale producers	Private sectors
7	HPKJ	Jepara Wood Trader Association	Associate wood traders	Private sectors
8	STIENU	Higher School of Economics Nahdatul Ulama	College for economy	College
9	STTDNU	Higher School of Design Technology Nahdatul Ulama	College for furniture design	College
10	SMIK	High School	School for wood craft and technology	School
11	DPRD Komisi B	District Parliament, Commission B	Represent people	Parliament
12	ASEPHI	Handicraft Exporter and Producer Association	Associate for exporting	Private sectors
13	FRK	Clusters Discussion Forum	Forum for furniture discussion	Multi-stakeholder forum
14	IWAPI	Indonesian Women Entrepreneur Association	Associate women entrepreneur	Private sectors
15	INDAG	District Industry and Trade Office	Execute government program on industry and trade	Government

16	Dinas UKM	District Small-scale Enterprises Office	Execute government program on Cooperation and small-scale enterprises	Government
17	DISHUT	District Forestry Office	Execute government program on forestry	Government
18	PERHUTANI	State Owned Forest Enterprise	State owned forest company in Java	Government
19	LAKPESDAM NU	Human Resources Research and Development Agency of Nahdatul Ulama	Channel people voice	NGO
20	DRD (*Dewan Riset Daerah*)	District Research Council	Research at local level	NGO
21	Bupati Office		Head of Jepara Government	Government