Identification of institutional risks of SMEs supply chain using the fuzzy failure mode and effect analysis

I Santoso, I Y Prahastuti and D A Pusfitasari
Department of Agro-industrial Technology, Faculty of Agricultural Technology, Universitas Brawijaya, Malang, Indonesia

Email: imamsantoso@ub.ac.id

Abstract. Institutional problems experienced by SMEs pose institutional risks that may affect their supply chain. The variables include involved actor, relationship and institution. The actor as a variable poses the risks of technical and intellectual knowledge, and negotiation skills, not to mention the issues of commitment, communication and responsibility. The relationship as a variable revolves around the issues of trust, honesty and motivation to improve, frequent conflicts, and limited information. Other institutional variables pose the risks of under-developed business networks and insufficient government involvement and training, and fundings. These risks must be handled properly and correctly. This study was aimed to identify and to assess institutional risks in supply chains. The risk identification and assessment in this research employed the Fuzzy Failure Mode and Effect Analysis (Fuzzy FMEA). The result from analysing five randomly selected SMEs revealed that the prioritised risks for actor as a variable included the lack of intellectual knowledge and poor commitment level. The prioritised risk for relationship as a variable was the lack of motivation to improve together. The prioritised risk for other institutional variables was the limited funding from other institution.

1. Introduction
Supply chain is a concept or mechanism to increase the overall productivity of a company through optimisation of time, location, and material flow. A supply chain in manufacturing includes suppliers, manufacturers, distributors and retailers [1]. Institutional aspects are important in creating a smooth supply chain [2, 3].

Success in developing SMEs may be affected by several factors, including a good institutional structure. Institution is crucial to be included in the pursuits of goals through following a system of norms, habits, and also through managing the relationships among business actors, either individuals or institutions, in the management of natural resources [4-6]. A simple supply chain includes components called channels, basically consisting of suppliers, manufactures, distribution centers, wholesalers, and retailers, who work together to meet the needs of consumers [7]. Integrated institutions may increase competitiveness and streamline supply chains. Institutional supply chain is the relationship between two or more institutions (components) in supply chain activities [8].

In a supply chain system, the partnership process revolves around the companies’ commitment, trust and collaboration [9, 10]. The problems on the related institutional aspect may include the limited funding provided by partners. These problems may pose risks that can disrupt the flow of institutional supply chain; hence a risk assessment is necessary.

Failure mode and effect analysis (FMEA) is a tool systematically identifying the effects or consequences of failures or systems or processes, and reducing or eliminating the chances of failure [11-13]. The FMEA method will define anything that is broken and why the damage occurs [14, 15]. A new Fuzzy FMEA was proposed that shall allow risk factors and relative factors to be evaluated linguistically in an appropriate way using fuzzy risk priority number (Fuzzy RPN), rather than RPN crips or fuzzy if-then to set the priority failure modes [16].
2. Research Methods
Data collection was conducted through surveys, interviews and questionnaires. Surveys and interviews were completed to identify agro-industry institutional risks, while the questionnaire was used to evaluate production risks in 5 randomly selected agro-industry companies namely BE, KS, PJ, KF and WK. Data analysis and processing were conducted from April 2018 to July 2018. Research data processing was completed at the Agro-Industry Management Laboratory, Department of Agroindustrial Technology, Brawijaya University, Malang, Indonesia. The respondents of the study were expert respondents, including managers of the SMEs selected for the study.

Research stages include:
1. Identifying the risks in the institutional supply chain of each SME
2. Evaluating the institutional risks for each SME’s supply chain
3. Risk assessment and ranking are based on the value of Fuzzy RPN using the Fuzzy FMEA method.

The risk measurement employed the Fuzzy FMEA method to obtain the priority level of institutional risks. Fuzzy FMEA is a more developed FMEA method, with the addition of fuzzy concepts to the initial FMEA algorithm, allowing the linguistic data and numerical data used to have membership values for each attribute [16]. Fuzzy FMEA is a method that uses fuzzy logic in identifying problems or causes of risk that occur through consideration of severity (S), occurrence (O), and detection (D) criteria. Severity (S), is a quantification of how serious the condition is when a failure occurs. In the Fuzzy FMEA method, the S, O, and D and their relative importance can be evaluated linguistically. The terms linguistic and Fuzzy number are used to evaluate factors S, O, and D as well as the relative importance. Assessment of failure mode factors uses the FMEA method in fuzzy logic [17].

3. Results and Discussion
3.1. Identification of institutional risks
Institutional risks identification was aimed to determine the factors affecting each institutional variable. The identification result indicated that there were three production variables, including actors, relationships, and management. Each variable had risk components. Risk identification for each institutional variable is presented in Table 1.

| Table 1. Institutional risks identification |
|--------------------------------------------|
| Variable of Risk                          | Components of Risks                      |
| Actor                                     | - Minimum technical knowledge            |
|                                            | - Minimum intellectual knowledge          |
|                                            | - Poor communication skills               |
|                                            | - Poor commitment level                    |
|                                            | - Poor responsibility level                |
|                                            | - Poor negotiation skills                  |
| Relationship                               | - Honesty issue                           |
|                                            | - Trust issue                             |
|                                            | - Consistency issue                       |
|                                            | - Limited information                     |
|                                            | - Conflicts among actors                  |
|                                            | - Lack of motivation to improve together  |
| Management                                | - Limited funding from other institutions |
|                                            | - Minimum partnership with other actors   |
|                                            | - Minimum government involvement and training |
|                                            | - Under-developed business networks        |

3.2. Prioritised risk: actor as a variable
Actor in the agro-industry institutional system contributed to the occurrence of risks. The result of the identification of risks for actor as a variable in the system included: minimum technical knowledge, minimum intellectual knowledge, poor communication skills, poor commitment level, and poor responsibility level. The result of risk analysis for actor as a variable in agro-industry SMEs is presented in Table 2.
Table 2. Prioritised risk for actor as a variable

| Components of Risk                  | BS SME | KS SME | PJ SME | KF SME | WK SME |
|-------------------------------------|--------|--------|--------|--------|--------|
| Minimum technical knowledge         | 7.09   | 9.743  | 5.592  | 5      | 2.997  |
| Minimum intellectual knowledge      | 7.689  | 9.743  | 5.592  | 4.661  | 1.771  |
| Poor communication skills           | 5.422  | 9.16   | 5.592  | 5.482  | 5.284  |
| Poor commitment level               | 4.804  | 9.641  | 7.114  | 3.548  | 7.44   |
| Pool responsibility level           | 5.966  | 9.641  | 7.114  | 4.919  | 4.479  |
| Poor negotiation skill              | 5.785  | 9.431  | 4.804  | 5.785  | 2.756  |

The results showed that the BS SME and KS SME actors had the same prioritised risk, which was the minimum intellectual knowledge. Values for the two SMEs were 7.689 and 9.743, respectively. Intellectual capital was one of the non-physical resources or intangible assets that was not visible in the company's financial statements (balance sheet). The role of intellectual capital is very influential on employee performance, and in the long run will affect organisational performance. Intellectual capital is related to human knowledge and experience, and the technology used [18]. KS SME had two risk components that were prioritised, including minimum intellectual knowledge and minimum technical knowledge. Competence is the most difficult component to imitate, because it is specific to each individual [19]. PJ SME and WK SME had the same prioritised risk, which was poor commitment level. The values for the two SMEs were 7.114 and 7.44, respectively. Poor commitment level had the highest risk value thus affecting the SMEs’ institutional supply chain significantly. This is in line with consumer behavior [20]. Organisational commitment is a combination of attitudes and behaviors with regard to identifying with organisational goals, a sense of belonging to organisational goals and a sense of loyalty to the organization [21]. N.V. PJ had two prioritised risk components including poor commitment level and poor responsibility level. The prioritised risk for KF SME was the poor negotiation skills, with a value of 5.785. Diplomacy included negotiation, which was the process of macropolitical interactions among actors, carried out to affect a number of objectives by establishing mutual agreements. After a negotiation is completed, the agreements shall be documented and signed by relevant parties [22].

3.3. Prioritised risks: relationships as a variable

Risk variable is an important factor in agro-industry institutions. There are a number of risk components in agro-industry institutions. The risk components and risk values are presented in Table 3.

Table 3. Prioritised risk for relationship as a variable

| Components of Risk                  | BS SME | KS SME | PJ SME | KF SME | WK SME |
|-------------------------------------|--------|--------|--------|--------|--------|
| Honesty issue                       | 5.785  | 9.641  | 5.156  | 6.153  | 1.131  |
| Trust issue                         | 6.635  | 9.641  | 5.156  | 5.378  | 2.203  |
| Consistency issue                   | 7.097  | 8.915  | 5.156  | 6.903  | 1.542  |
| Limited information                 | 6.882  | 9.51   | 4.804  | 7.487  | 3.582  |
| Conflicts among actors              | 6.629  | 9.474  | 4.804  | 5.253  | 1.1    |
| Lack of motivation to improve together | 5.851 | 9.474  | 5.592  | 5.72   | 4.273  |

The result showed that for BS SME, relationship as a variable suggested poor consistency as the prioritised risk, with a value of 7.097. Consistency between planning and budgeting is important because it is an indicator in assessing the performance of an SME, to make sure that all SME programs and activities run well to achieve the decided goals. This is crucial for the achievement of the vision, mission, goals, objectives and policies that have been planned in the planning document [23]. KS SME had two prioritised risk components, including the honesty issue and the trust issue, with a value of 9.641. Trust is the foundation for a business process. Trust is not something that can emerge instantly in a business, it must be built from the beginning [24]. Trust is a very broad concept. The components of trust consist of integrity, kindness, competency and predictability [25].
PJ SME and WK SME had the same prioritised risk, which was the lack of motivation to improve together. The two SMEs showed the values of 5.592 and 4.273, respectively. Employees who have high morale get the job done faster with a minimum damage. With them, absenteeism can be minimised, complaints and warnings can be avoided, and strikes can be eliminated. The stronger the work motivation, the better the employee's performance. This means that any increase in employee motivation will improve their performance [5].

The prioritised risk for KF SME was the limited information, with a value of 7.487. SMEs generally use manual technology. The under-development of technology used results in the small number of production and poor efficiency of the production process, as well as the low quality of the products produced, hence the inability of the SMEs to compete in the global market [5-6].

3.4. Prioritised risks: management as a variable
Management is one of the agro-industry institutional risk variables. There are a number of risk components in agro-industry institutional risks as presented in Table 4.

| components of Risk                                      | BS SME | KS SME | PJ SME | KF SME | WK SME |
|---------------------------------------------------------|--------|--------|--------|--------|--------|
| Limited funding from other institutions                 | 7.097  | 8.485  | 8.476  | 6.544  | 6.2    |
| Minimum partnership with other actors                   | 5      | 6.473  | 7.897  | 6.491  | 4.299  |
| Minimum government involvement and training              | 6.635  | 7.811  | 7.114  | 7.097  | 2.347  |
| Under-developed business networks                       | 6.544  | 9.21   | 7.114  | 4.555  | 7.102  |

The result revealed that management as a variable for BS SME, KS SME and PJ SME indicated the same prioritised risk, which was limited funding from other institutions. The three SMEs showed the values of 7.097; 8.485 and 8.476. The risk of limited funding from other institutions occurs when there are many SMEs of the same type with the same scale of business requesting loan from available government agencies for the same amount. The prioritised risk for KF SME was the lack of government training and involvement. Training is a short-term educational process that uses systematic and organized procedures to enable non-managerial employees to learn technical knowledge and skills for specific purposes [26]. The prioritised risk for WK SME was the under-developed business networks. Business networks can be a solution to the problems experienced by SMEs in facing a growing economy. An effective MSME business networking can be done by utilising social networks through Online Groups, Twitter, Line, Facebook, BBM, and WhatsApp [27].

4. conclusions
The institutional risk priorities for actor as a variable included lack of knowledge and poor commitment level. The prioritised risk for relationship as a variable was the lack of motivation to improve together. The prioritised risk for other institutional variables included limited funding from other institutions. The further research is formulating alternative risk mitigation strategies for each risk variable with the most appropriate priority determination method.

References
[1] Christoper M 2016 Logistic and supply chain management Pearson UK.
[2] Maflahah I 2010 Analisis proses pembuatan pati jagung (maizena) berbasis neraca massa (The mass balance-based process analysis of corn starch (maizena)) Embryo 7 1 112-119. [In Indonesia]
[3] Saadah M, Santos I, Mustaniroh S A 2019 Analysis of institutional paprika supply chain in Pasuruan Regency IOP Conf. Ser. Earth and Environ. Sci. 230 012069 1-7.
[4] Ruhimat I S 2016 Faktor kunci dalam pengembangan kelembagaan agroforestry pada lahan
masyarakat. *J. Penelitian Sosial dan Ekonomi. Kehutanan* **13** 2 73-84.

[5] Santos I, Framewares P A I, Yushila A B, Arwani M 2019 Fuzzy sequential model for strategic planning of small and medium scale industries *TELOKMINIKA* **17** 3 1310-1316.

[6] Purnama J, Setiawan B, Santos I, Yanuwiadi B 2018 Decision support system fuzzy goal programming model to optimize benefits of SME furniture *Int. J. Eng. Technol.* **7** 4 6579-6584.

[7] Anatan L 2010 Pengaruh implementasi praktik-praktik manajemen rantai pasok terhadap kinerja rantai pasok dan keunggulan kompetitif (The effect of implementing supply chain management practices on supply chain performance and competitive advantage) *Karisma* **4** 2 106-117. [In Indonesian]

[8] Rahayu R E, Lindawati K 2015 Analisis kelembagaan dan strategi peningkatan daya saing komoditas kentang di Kabupaten Banjarnegara Jawa Tengah (Institutional analysis and strategy to improve the competitiveness of potato commodities in Banjarnegara Regency, Central Java) *JIPI* **20** 2 150-157. [In Indonesian]

[9] Ryu I, So S, Koo C 2009 The role of partnership in supply chain performance *Ind. Manage. Data Syst.* **109** 4 496–514.

[10] Kurniawan M, Santos I, Kamal M A 2019 Risk management of shallot supply chain using failure mode effect analysis and analytical network process (Case study in Batu, East Java) *IO Conf. Ser. Earth Environ. Sci.* **230** 012055 1-6.

[11] Lipol L S, Haq J 2011 Risk analysis method: FMEA/FMECA in the organizations *Intl. J. Bas. Appl. Sci.* **11** 5 74-75.

[12] Santos I, Sa’adah M, Sari E N, Framewares P A I, Agustina C R 2018 The integration of MAFMA and AHP methods for analysis and risk mitigation of pasteurized milk production *J. Eng. Technol. Sci.* **50** 5 670-683.

[13] Rahmatin N, Santos I, Indriani C, Rahayu S, Widyaningtyas S 2018 Integration of the fuzzy failure mode and effect analysis (Fuzzy FMEA) and the analytical network process (ANP) in marketing risk analysis and mitigation. *Int. J. Technol.* **9** 4 809-818.

[14] Yasa W, Dharma S, Sudipta K 2013 Manajemen risiko operasional dan pemeliharaan tempat pembuangan akhir (TPA) Regional Bangli Di Kabupaten Bangli (Operational risk management and maintenance of Bangli Regional landfills in Bangli Regency) *J. Spektra* **12** 30-38, [In Indonesian]

[15] Yusuf D T C, Santos I, Ikasari D M 2018 Sugar manufacturing process: Risk analysis and mitigation using fuzzy FMEA and Fuzzy AHP method *Biosci. Res.* **15** 3 1575-1582.

[16] Iqbal M, Laili M, Nanang Y S 2013 Penggunaan fuzzy failure mode and effect analysis (fuzzy FMEA) dalam mengidentifikasi risiko kegagalan proses pemasangan dan perbaikan AC (The use of fuzzy failure mode and effect analysis (fuzzy FMEA) in identifying the risk of failure of the AC installation and repair process) *Teknologi Informasi dan Ilmu Komputer* **2** 7 1-6. [In Indonesian]

[17] Wang Y M, Kwai S C, Gary K K 2009 Risk evaluation in failure mode and effect effects analysis using fuzzy weighted geometric mean. *J. Exp. Syst. App.* **36** 1195-1207.

[18] Helmiantin 2015 Optimalisasi peran modal intelektual terhadap kinerja karyawan (Optimising the role of intellectual capital on employee performance) *Etikonomi* **14** 1 51-68. [In Indonesian]

[19] Mulyana A 2014 Pengembangan koperasi kota bandung melalui pemetaan pelaku usaha koperasi dan usaha unggulannya (Development of Bandung city cooperatives through mapping of cooperative business actors and their superior businesses) *Jurnal Manajemen Bisnis Indonesia* **1** 3 385-397. [In Indonesian]

[20] Alamsyah D P, Trijumantsyah A, Hariyanto O I 2017 Mediating of store image on customer trust for organic vegetables *MIMBAR, Jurnal Sosial dan Pembangunan* **33** 1 132–140. [In Indonesian]

[21] Nurdin S, Rohendi A 2016 Gaya kepemimpinan transformasional, budaya organisasi, dan kinerja karyawan dengan mediasi komitmen organisasi (Transformational leadership style, organizational culture, and employee performance by mediating organizational commitment) *J. Ecodemica* **4** 1 86–100. [In Indonesian]

[22] Matondang E 2015 Pentingnya kapabilitas negosiator dalam kerja sama internasional di bidang teknologi pertahanan: kasus proyek kfx/ifx (The importance of negotiator capabilities in international cooperation in the field of defense technology: the case of the kfx / ifx project)
[23] Osrinda N Delis A 2016 Analisis Konsistensi Perencanaan dan Penganggaran serta Implikasinya terhadap Capaian Target Kinerja pada Badan Perencanaan Pembangunan Daerah Kabupaten Merangin (Analysis of the consistency of planning and budgeting and its implications on the achievement of performance targets at the merangin district regional development planning agency) Jurnal Perspektif Pembiayaan dan Pembangunan Daerah 3 3 151-162. [In Indonesian]

[24] Hendrata Y K, Purbandari T, Mujilan 2013 Pengaruh structural assurance dan perceived reputation terhadap trust pengguna internet di sistem e-commerce (The effect of structural assurance and perceived reputation on internet users’ trust in e-commerce systems) J. Riset Manajemen dan Akuntansi 1 1 81-88. [In Indonesian]

[25] McKnight D H, Chervany N L 2002 What trust means in e-commerce customer relationships: an interdisciplinary conceptual typology Int. J. Electr. Commer. 6 2 35-59.

[26] Irawati R 2018 Pengaruh pelatihan dan pembinaan terhadap pengembangan usaha kecil (The effect of training and coaching on the development of small businesses) JIBEKA 12 1 74-82. [In Indonesian]

[27] Fiati R, Zuliyati 2016 Strategi pengembangan jaringan usaha UMKM pigura kaligrafi memasuki pasar ekspor (Strategy for developing the SMEs business network for calligraphy frames entering the export market) J. DIANMAS 5 1 53-62. 82. [In Indonesian]