Pangasius (Catfish) Production in Vietnam: Risk and Risk Management, Technology Adoption, and Sustainability

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Contents:

- **Project 1: Risk Management Framework for Vietnamese Aquaculture: The Case of Vietnamese Catfish (Pangasius), 2008-2011.**
  - *in collaboration with RMIT University, Melbourne, Australia)*
  - *(investigators: Tru Cong Le, France Cheong, and Chris Cheong)*

- **Project 2: Economic analysis of Recirculting Aquaculture System (RAS) to improve sustainability of Vietnamese pangasius production, 2012-2016**
  - *(in collaboration with Wageningen University, Wageningen, The Netherlands.*
  - *(investigators: Pham Thi Anh Ngoc, Miranda P. M. Meuwissen, Tru Cong Le, Roel H. Bosma, Johan Verreth and Alfons Oude Lansink*

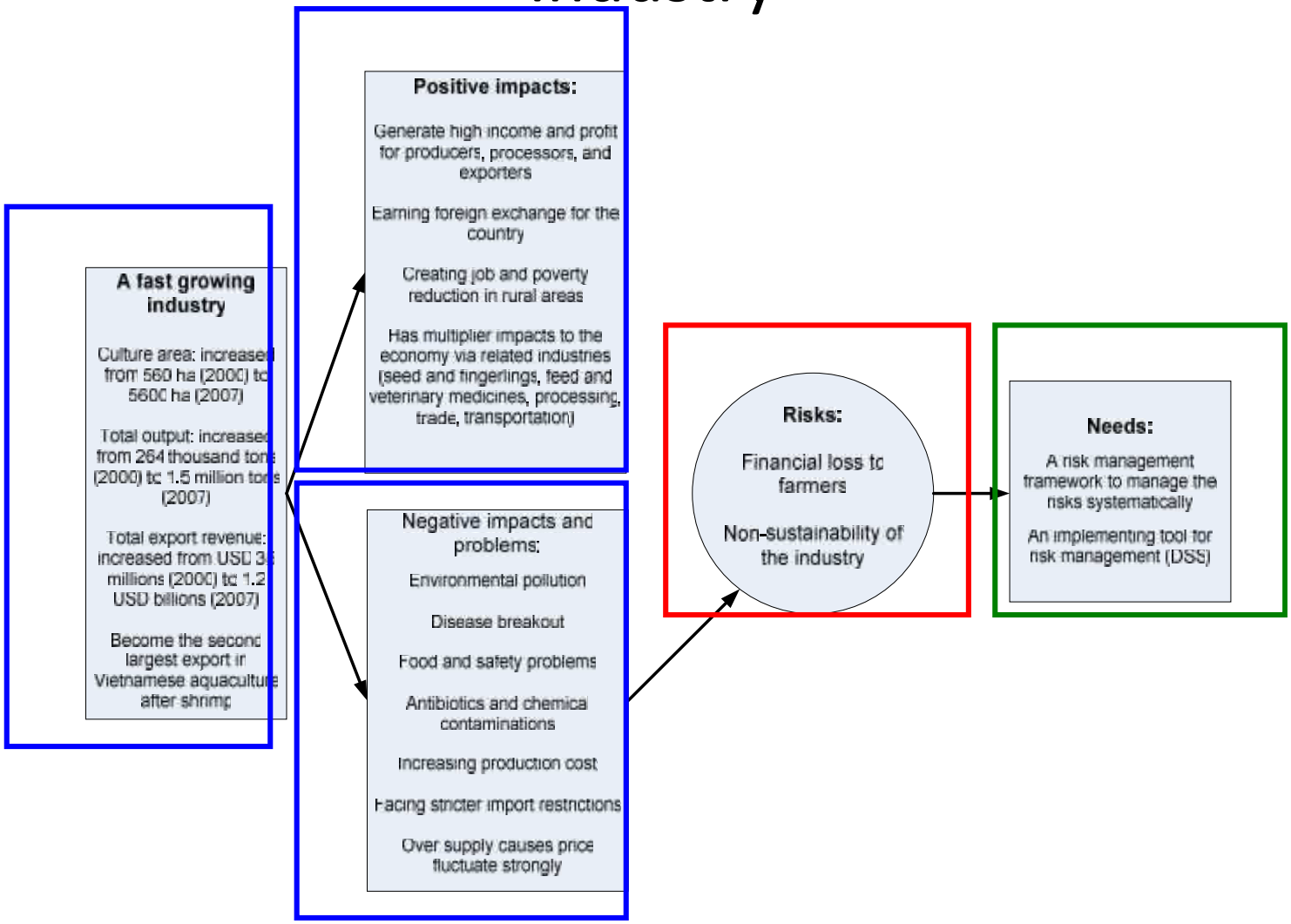
Project 1: Risk Management Framework for Vietnamese Catfish

1. Main objective:

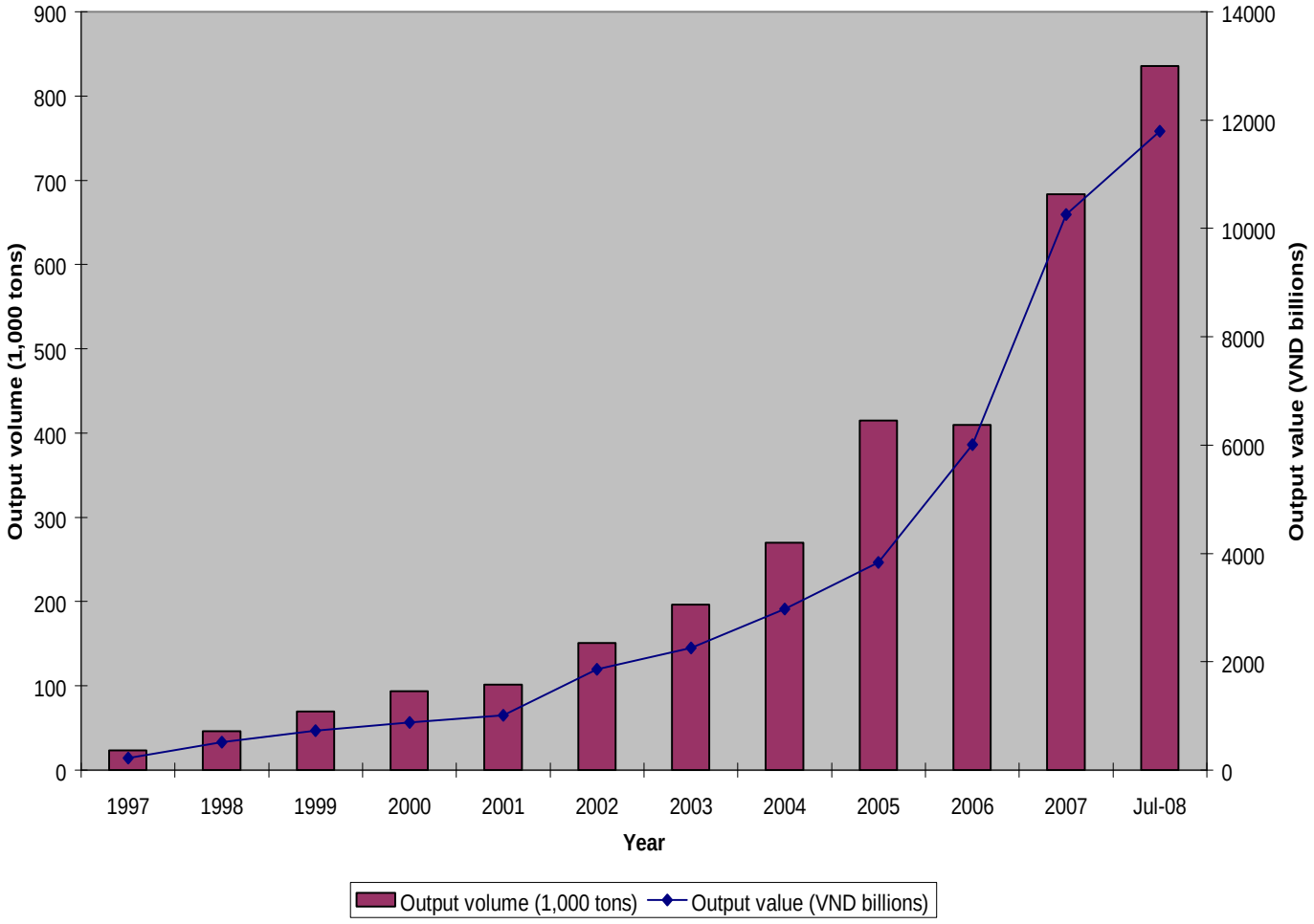
   Developing a risk management framework for Vietnamese catfish farming

2. Sub-objectives:
   1. Determining perceptions of risks and risk management of Vietnamese farmers
   2. Developing a risk management framework for Vietnamese catfish farming
   3. Implementing and evaluating a DSS for risk management in Vietnamese catfish farming

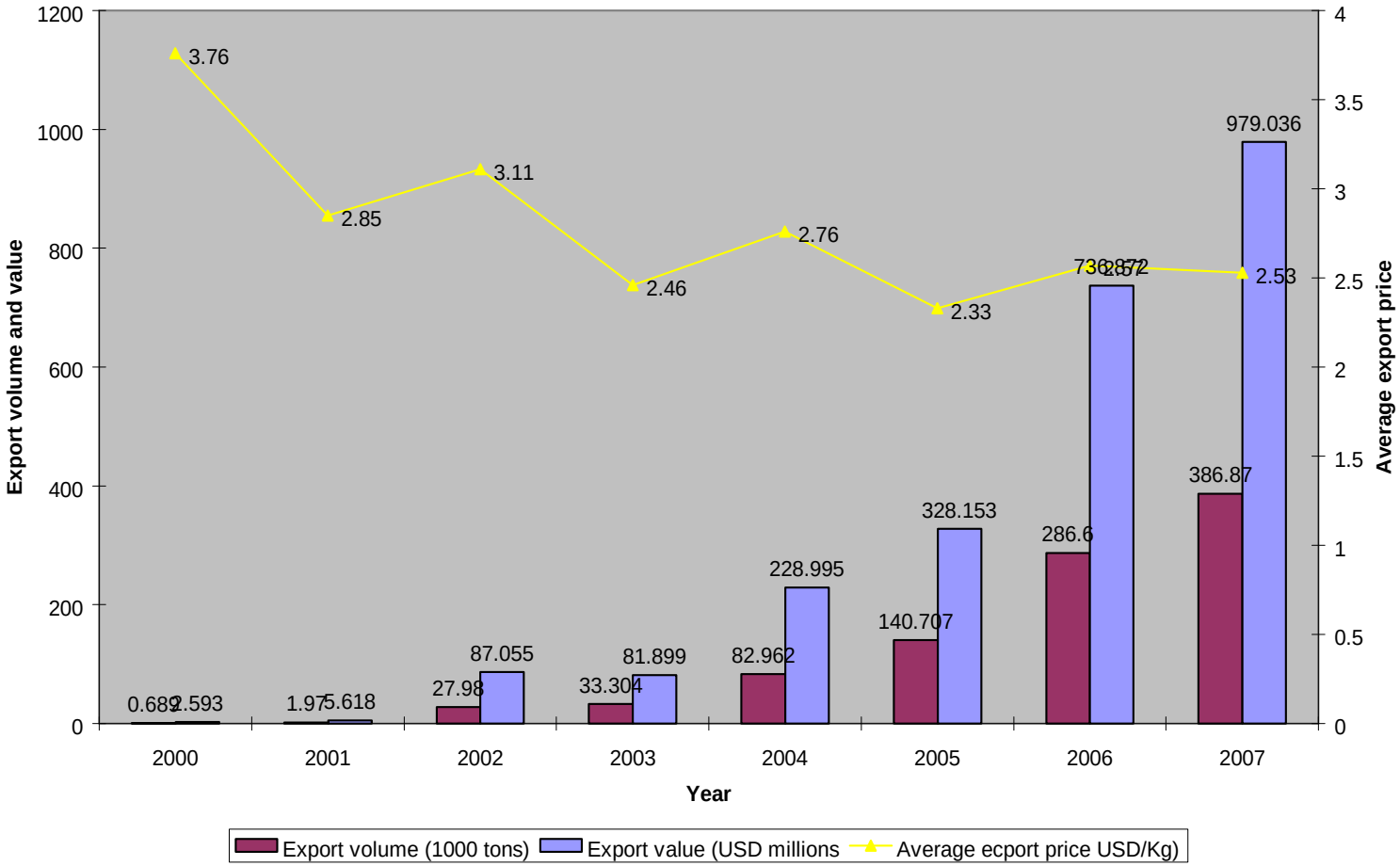
Introduction: Issues with Vietnamese Catfish Industry



Catfish production: Fast growth



Catfish exports: Decreasing and fluctuating prices



Opportunities and Challenges

- Opportunities
  - High demand from export market
  - Comparative advantages in catfish production
  - Supported by government

- Challenges
  - Increasing production costs
  - Decreasing selling prices
  - Decreasing profitability
  - Frequent disease breakouts
  - Stricter import barriers
  - Higher standards for food safety and hygiene

Methodology

Methodology and Research Steps

Research objective 1

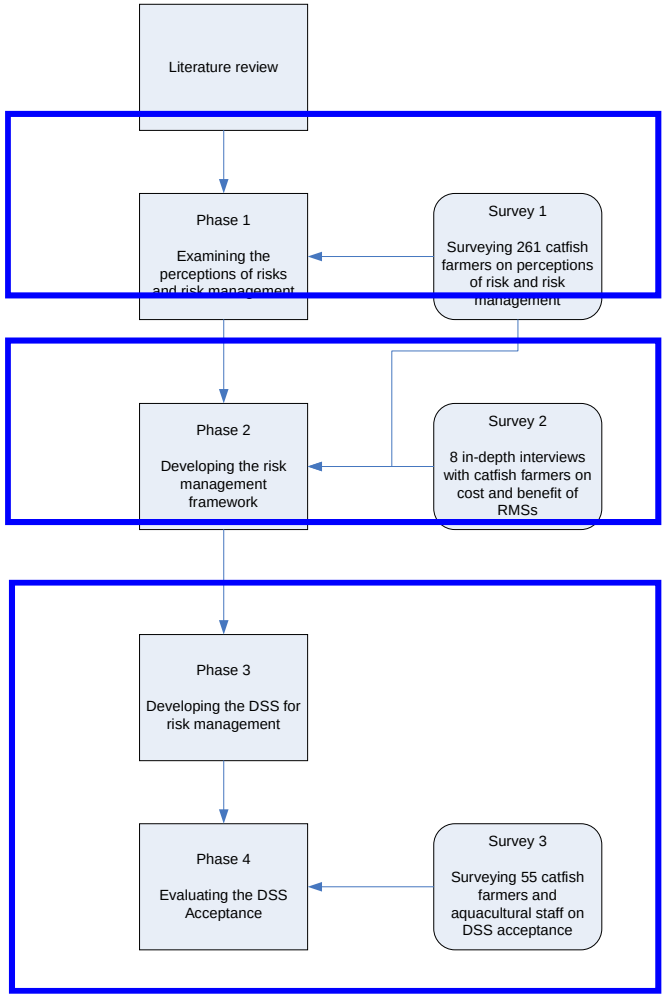
Examining the perceptions of risks and risk management

Research objective 2

Developing a risk management framework

Research objective 3

Developing a DSS for risk management



Methods used

Factor analysis

Multiple regressions

BPM

AS/NZS 4360 RMP

PDF (data fitting)

System Approach

SEM

Results and Discussions

Phase 1: Perceptions of risks and risk management

Data collection and data analysis

- Data collection: fresh survey of 261 catfish farmers in the Mekong delta
- Data analysis methods:
  - Exploratory Factor Analysis
    - Reducing 40 sources of risk into 6 categories of risk
    - Reducing 50 risk management strategies into 6 categories of RMS
    - Standardized factor scores were used as dependent variables in subsequent regressions
  - Multivariate Regression
    - $RF_{i,t} = f(Consult_t, D_large_t, D_medium_t, Age_t, Education_t, Experience_t, Gender_t, \varepsilon_t)$ **(1)**
- **and**
    - $RMF_{j,t} = f(Consult_t, D_large_t, D_medium_t, Age_t, Education_t, Experience_t, Gender_t, RF_{i,t}, e_t)$ **(2)**

Results of Multiple Regressions for Sources of Risk

	Sources of risk					
Independent variables	**Disease and environment**	**Production**	**Natural conditions**	**Price and credit[e]**	**Legislation**	**Pond location[e]**
Intercept	*0.92	-0.42	0.07	0.42	**1.32	**-0.98
Consult [a]	*-0.28	**0.34	***0.52	-0.06	-0.12	**0.51
D_large [b]	**0.35	***0.52	-0.16	0.26	***-0.64	***0.55
D_medium [c]	**0.42	*0.25	0.06	0.26	-0.1	**0.31
Age (years)	**-0.02	0	0	*-0.01	**-0.01	**0.02
Education (years)	0.03	0.01	-0.01	-0.01	-0.02	-0.01
Experience (years)	0	0	***-0.04	0	***0.04	-0.02
Gender [d]	*-0.29	0.13	-0.25	0.22	-0.32	-0.09
R-squared	***0.12	***0.08	***0.08	0.04	***0.10	***0.10
R-squared adjusted	0.09	0.05	0.05	0.01	0.07	0.07
	29.45	35.83	36.93	46.79	30.25	49.87
White heteroscedasticity statistics[f]	-0.4937	-0.2137	-0.1791	-0.026	-0.453	0.0128)
Durbin-Watson statistics	1.98	1.91	1.36	1.61	1.64	1.65

‘*’, ‘**’ and ‘***’ denote levels of significance of 10%, 5% and 1% respectively for variables and models.

Results of Multiple Regressions for Risk Management Strategies

	Risk management strategies					
Independent variables	Farm management	Financial	Input quality	Extension/ Education	Disease prevention	Diversification
Farm/farmer characteristics						
Intercept	-0.31	-0.04	**-0.63	**1.14	*-0.89	-0.59
Consult[a]	0.12	-0.11	**0.42	-0.2	-0.07	***0.52
D_large[b]	*0.31	-0.13	-0.23	***0.75	0.17	0.23
D_medium[c]	**0.40	-0.04	-0.17	0.1	*0.26	-0.04
Age	0	0	0	-0.01	**0.01	0
Education	0	0	0.02	-0.01	*0.05	0
Experience	*-0.02	**0.02	0.02	**-0.03	-0.02	-0.02
Gender[d]	0.21	0.11	-0.09	***-0.65	-0.12	0.24
Sources of risk						
(1) Disease and environment	0	***0.46	**0.14	***0.14	***0.27	***0.28
(2) Production	0.05	***-0.3	***0.33	**0.13	***0.20	***-0.19
(3) Natural conditions	***0.44	***0.4	-0.03	-0.07	*-0.10	**-0.15
(4) Price and Credit	***0.21	-0.03	***0.16	***0.37	**-0.14	***-0.27
(5) Legislation	**0.13	***0.16	-0.09	***0.23	*-0.11	*0.10
(6) Pond location	***0.28	***-0.18	***0.25	***-0.28	-0.07	0.03
R-squared	***0.46	***0.56	***0.25	***0.45	***0.23	***0.25
R-squared adjusted	***0.43	***0.53	***0.20	***0.41	***0.18	***0.20

"*," "**," and "***" denote levels of significance of 10%, 5%, and 1% respectively for variables and models.

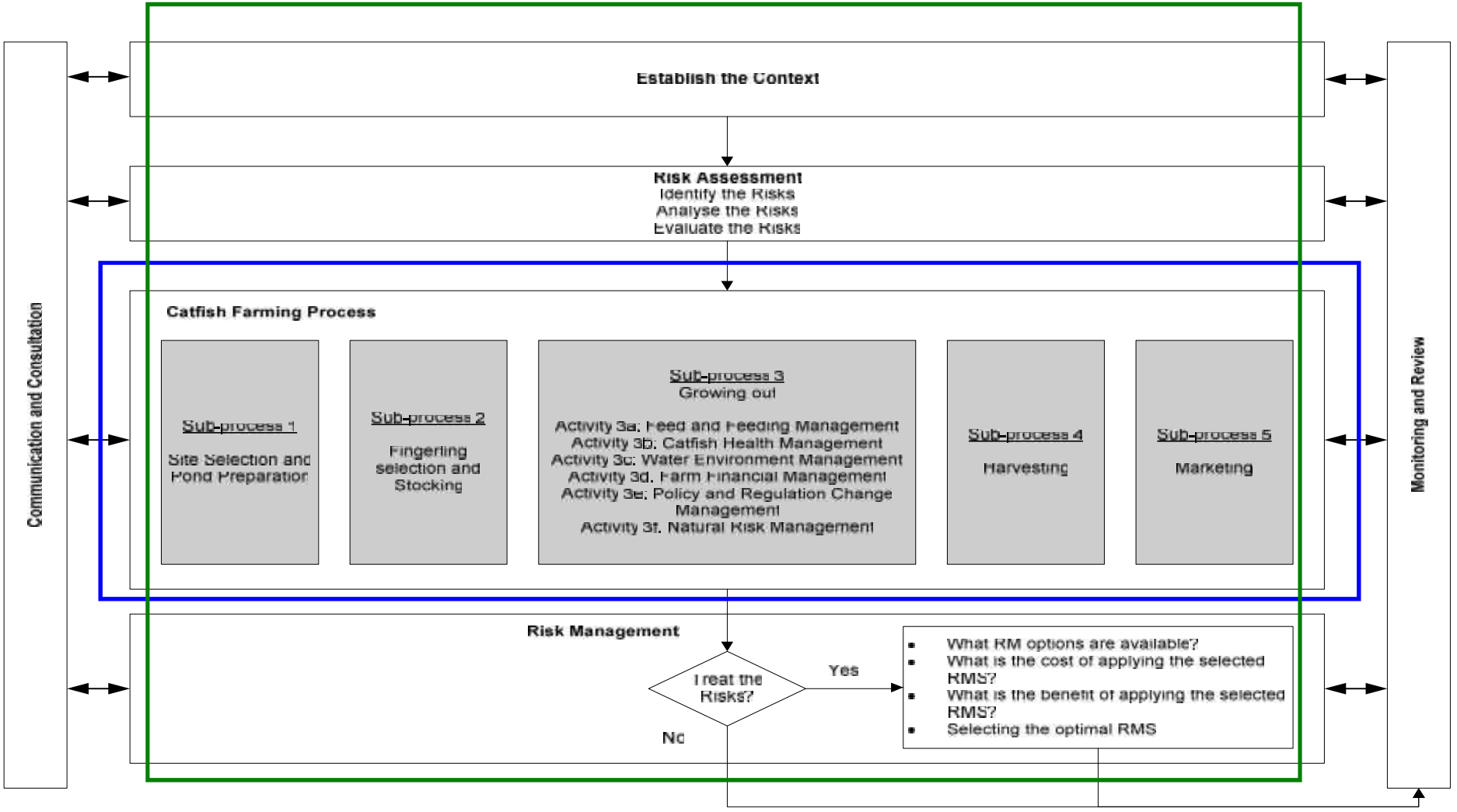
[a] Measured as a dummy variable, where 1 denotes farms taking external technical consultancy, 0 denotes not taking technical consultancy.

[b] Measured as a dummy variable, where 1 denotes large scale farm, which has a total area of pond greater than 2 hectares.

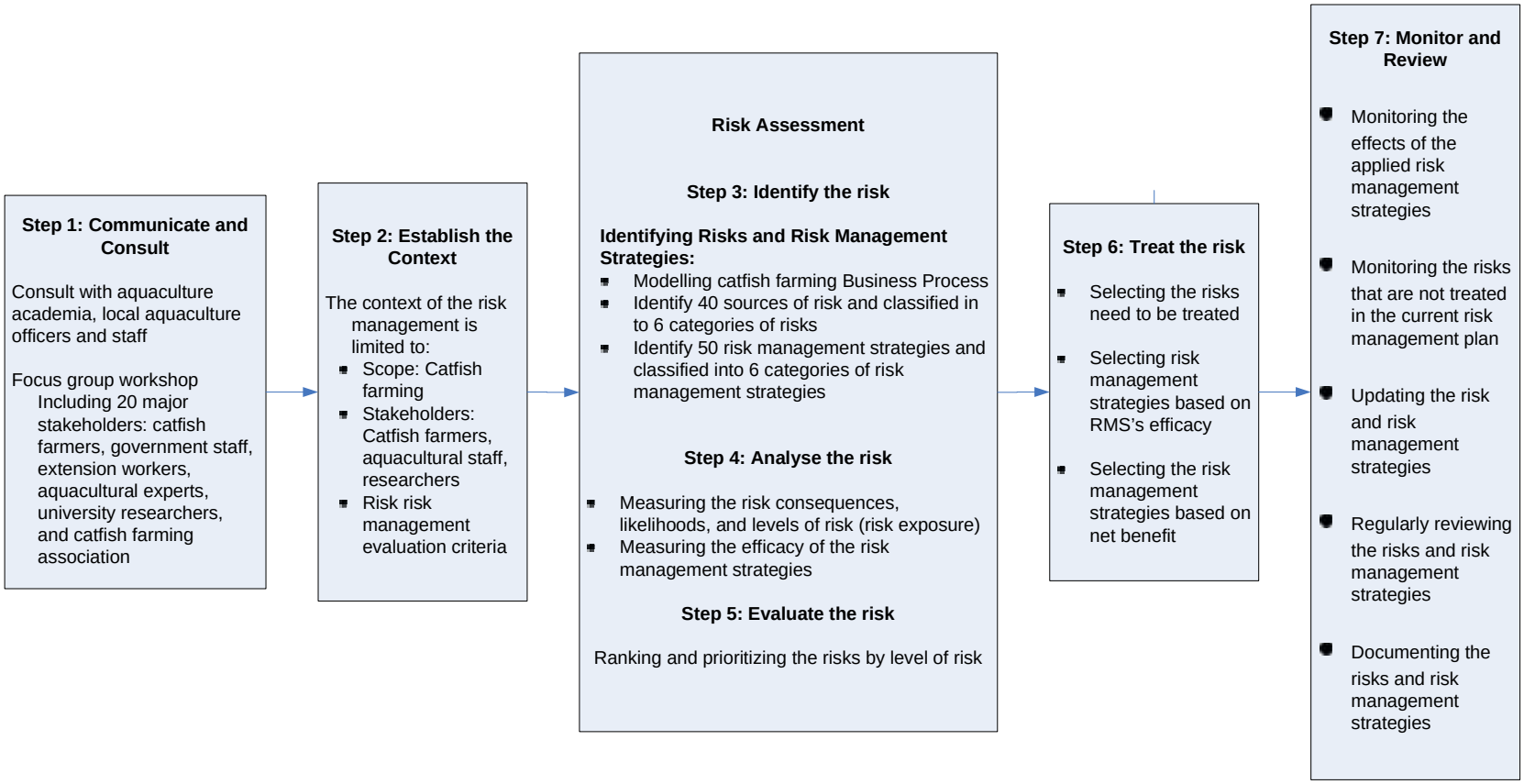
[c] Measured as a dummy variable, where 1 denotes medium scale farm with a total pond area between 0.5 and 2 hectares.

[d] Measured as a dummy variable, where 1 denotes male farm head, 0 denotes female farm head.

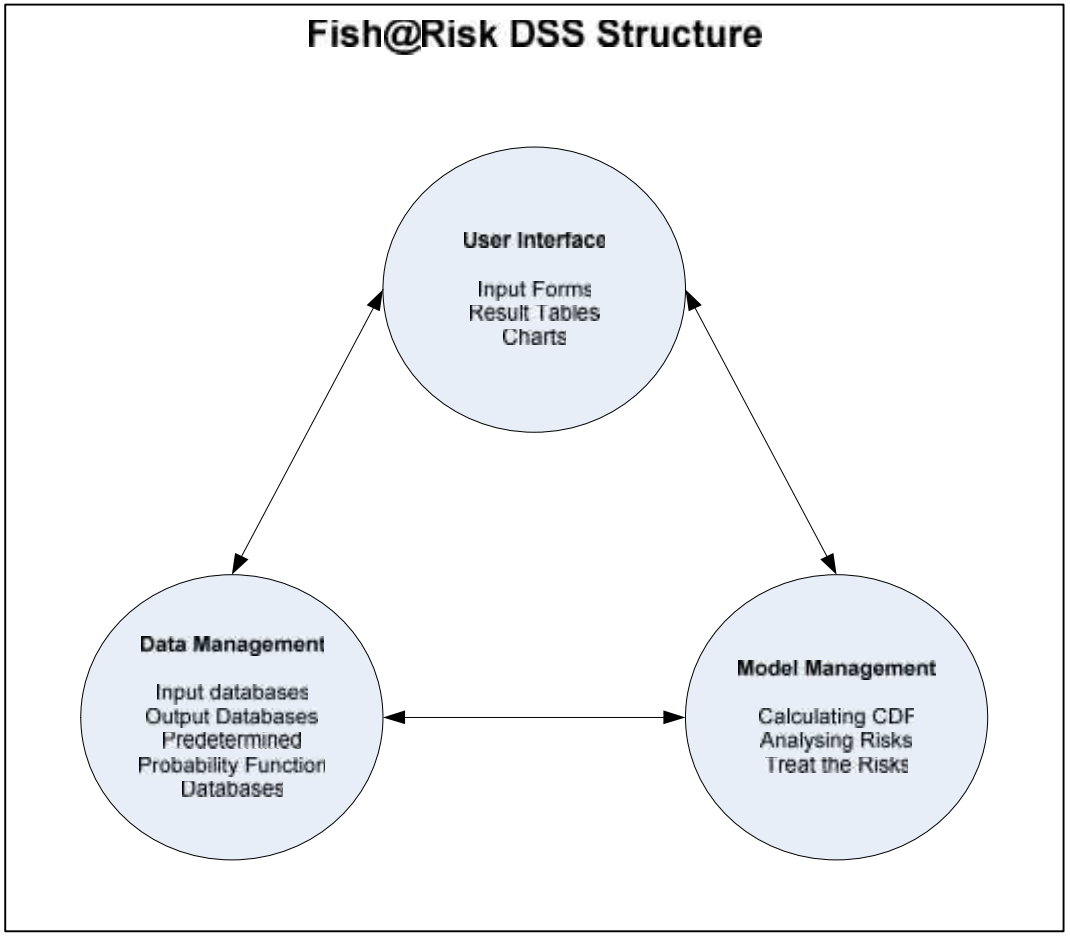
Phase 2: Catfish Risk management framework



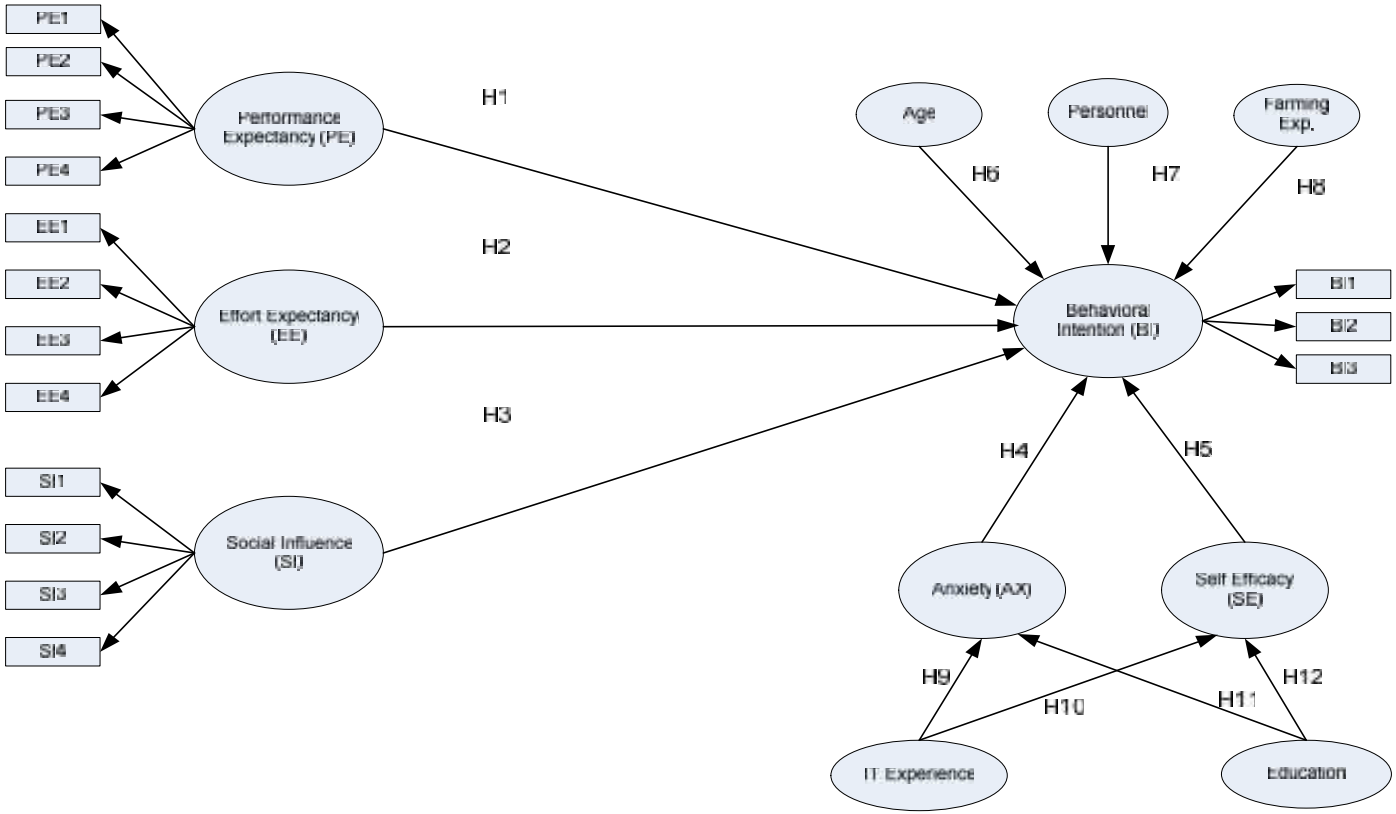
7 steps for developing a risk management framework



Phase 3: Architecture of Fish@Risk DSS



Phase 4: DSS Acceptance: Proposed Model for Evaluation



Survey Instrument Scales

- Performance expectancy: item PE1-PE4 (4 items), 1-5 Likert scale
- Effort expectancy : item EE1-EE4 (4 items), 1-5 Likert scale
- Social influence : item SI1-SI4 (4 items), 1-5 Likert scale
- Computer anxiety : item AX1-AX4 (4 items), 1-5 Likert scale
- Computer self efficacy : item SE1-SE4 (4 items), 1-5 Likert scale
- Behaviour intention : item BI1-BI3 (3 items), 1-5 Likert scale
- Other demographic variables:
  - Age : 1 item, 1-5 Likert scale
  - Computer experience, 1 item, 1-5 Likert scale
  - Education : 1 item, 1-5 Likert scale
  - Personnel : 1 item, 1-4 Likert scale
  - Farming experience : 1 item, 1-4 Likert scale
- 28 items are developed

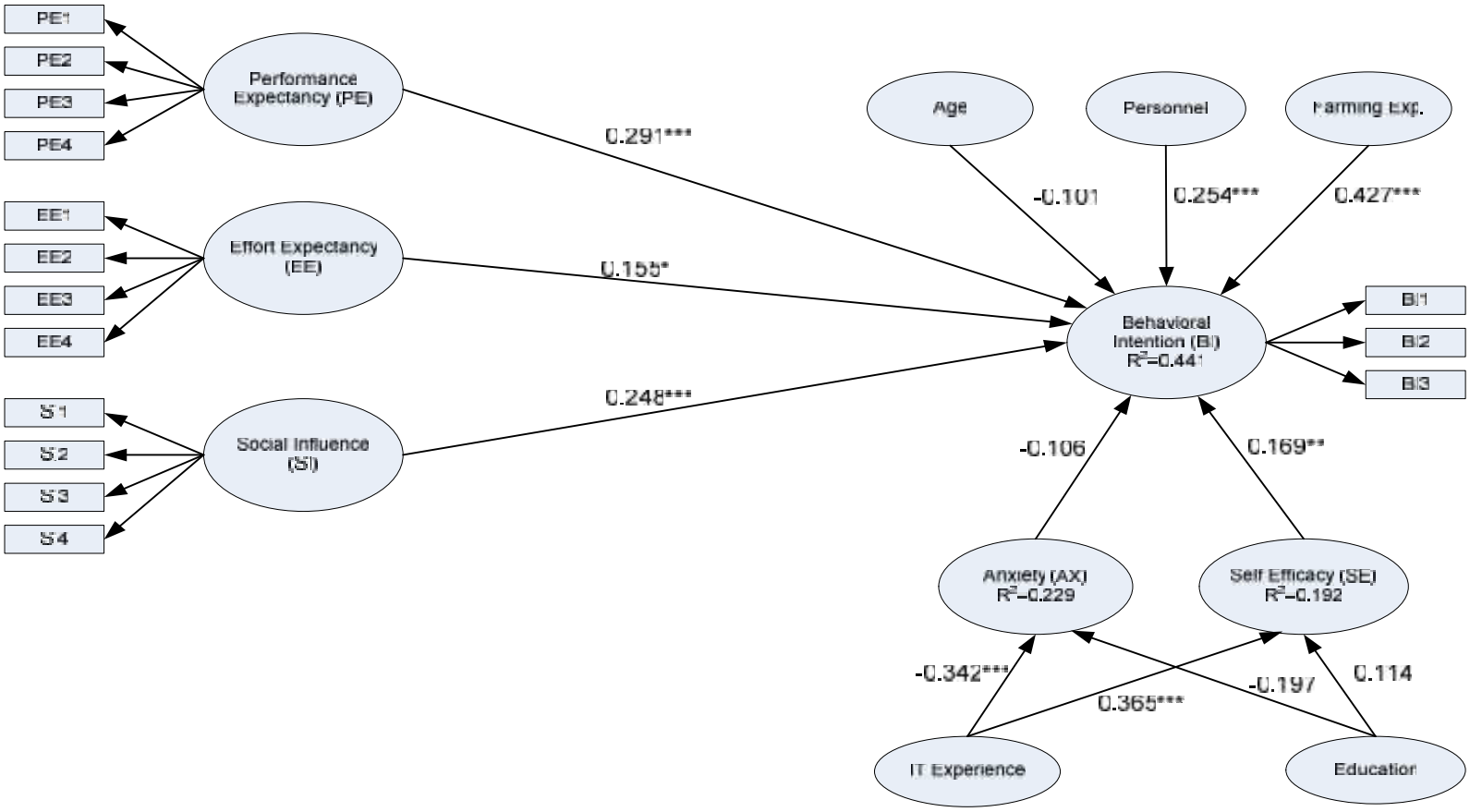
Data Collection

1. Training trainers (aquaculture staff): 3 trainers in each province
2. Training catfish farmers about the DSS: 15 catfish farmers in each province
3. Researcher trained the trainers about the DSS, then trainers tried the DSS
4. Trainers then train the catfish farmers about the DSS, then farmers tried the DSS
5. Face-to-face questionnaire survey
6. 45 catfish farmers and 10 aquacultural staff
7. Total of 55 usable observations

Reliability and Validity Testing

- Reliability
  - Cronbach's alpha coefficients
- Factor loading greater than 0.7
  - PE2, EE1, SI1, SE4 deleted
- Convergent validity
  - Factor loading greater than 0.7
  - Composite reliability (CR) greater than 0.6
  - Average Variance Extracted (AVE) greater than 0.5
- Discriminant validity
  - Square root of AVE of each construct greater than the correlation coefficients between itself and any other construct
- 24 items remained for further analysis

Structural Model



* P<0.1; ** P<0.05; *** P<0.01.

Total Effects on ‘Behaviour intention'

Hypothesis	Construct	Total effect
H1	Performance expectancy	0.291***
H2	Effort Expectancy	0.155*
H3	Social influence	0.248***
H4	Computer anxiety	-0.106
H5	Self efficacy	0.169**
H6	Age	-0.101
H7	Personnel	0.254***
H8	Farming experience	0.427***
H10 x H5	IT Experience (indirect effects via self efficacy)	0.365^{***} x 0.169^{**} = 0.062**
H9 x H4	IT Experience (indirect effect via anxiety)	-0.342*** x -0.106= 0.036
H12 x H5	Education (indirect effect via self efficacy)	0.014 x 0.169** = 0.002
H11 x H4	Education (indirect effect via anxiety)	-0.197 x 0.106 =0.021
R-squared		0.441

Conclusions: Development of the Vietnamese catfish industry

1. A fast growing industry
2. Strong fluctuations in terms of output volume, prices, cost, and profit
3. Highly risky business
4. The industry development is **not sustainable**

Perceptions of risks and risk management

- Perceptions of risk
  - Price and production risks were perceived as the most important risk sources

- Perceptions of risk management strategies
  - Price risk reduction strategies were not perceived as relevant strategies for price risk management
  - Farm management, disease prevention, and selecting good quality inputs were perceived as relevant risk management strategies

Developing a risk management framework

1. Identifying 40 sources of risks and 50 risk management strategies
2. Measuring the risk, using the Level of Risk (LOR), based on the mean scores, and/or probabilities.
3. Ranking the risks by LOR
4. Prioritizing the risks
5. Treat the risks if the LOR is greater than ALAAR using RMS efficacy or Cost-benefit efficiency.
6. Monitor and review

Developing a DSS for risk management

- The Fish@Risk DSS consists of three main components:
  - A Database system
  - A Model system
  - A Graphical User Interface
- DSS Functionalities:
  - to manage the input and output data
  - to conduct a risk analysis system (including calculating the LOR, ranking and prioritizing, and matching the risks with relevant RMSs)
  - To conduct cost-benefit analysis for applying a RMS
  - Suggesting the most effective and/or most economic efficient RMS to user

Modelling the DSS Acceptance

- **Core variables:**
  - Performance expectancy, effort expectancy, social influences, and self efficacy are important direct influences to behaviour intention
  - Performance expectancy showed the strongest effect on behaviour intention
  - Computer anxiety has no significant impact on behaviour intension
- **Demographic variables:**
  - Direct effects:
    - Personnel and farming experience have significant direct impact on behaviour intention
  - Indirect effects:
    - Computer experience significantly increases computer self efficacy and indirectly improves behaviour intention
    - Computer experience significantly reduces computer anxiety and indirectly increases behaviour intention
  - Age and education level have no significant impact on intention to use

Study completion (March 2008-June 2011)

Study	Publication
1. Measuring Risk in Vietnamese Catfish Farming	• Published in IFAC (2009) Proceedings, Amsterdam, the Netherlands
2. Efficacy of Risk Management in Vietnamese Catfish Farming	• Published in ???, 2010, Singapore
3. Perceptions of Risk and Risk Management in Vietnamese Catfish Farming: An Empirical Study	• Published in Aquaculture economics and management (2010)
4. DSS for risk management in Vietnamese Catfish Farming	• Published in HISC (2011) Proceedings, Hawaii, USA.

Project 2:Economic analysis of Recirculting Aquaculture System (RAS) to improve sustainability of Vietnamese pangasius production

- **Objectives of the study:**
  - To measure input- and output-specific technical and scale inefficiency of Vietnamese pangasius farmers and to assess the impact of farmers' demographics and farm characteristics on these technical and scale inefficiencies.
  - To analyse the economic feasibility of RAS in pangasius farming in Vietnam.
  - To investigate key determinants influencing the adoption of RAS by Vietnamese pangasius farmers.
  - To analyse price transmission along the international supply chain for frozen pangasius fillets.

Methodology

- Objective 1: Technical Efficiency: Optimization
- Objective 2: Economic Feasibility of RAS: Cost-Benefit Analysis, Monte Carlo Simulation
- Objective 3: RAS Adoption: Choice Modeling, Logit Regression, NPV approach
- Objective 4: Price Transmission along the chain: Vector of Error Correction Model (VECM)

1. Technical ineffeciency of Vietnamese pangasius farming

- The weighted average score of technical inefficiency relative for Vietnamese pangasius farmers is 0.31.
- Inefficient use of capital (by 42%) and low fish yield (by 30%) are the main challenges for enhancing the performance of Vietnamese pangasius production.

- Farmers farming in areas suffering from salt water intrusion are associated with a higher technical inefficiency in the production of fish yields.

2. Economic feasibility of Recirculating Aquaculture System in pangasius farming

- Cost price of two systems for the most recent production cycle 2012-2013

	Traditional system (reality)		RAS (expectation)	
	Medium (1-3ha) n=37	large (>3ha) n=18	Medium (1-3ha) n=11	Large (>3ha) n=18
Cost price (USD/kg)	1.10	0.91	1.07	0.98

Economic feasibility of Recirculating Aquaculture System in pangasius farming

- Monte Carlo simulation of economic

	Traditional system		RAS	
	Medium	Large	Medium	Large
Profit (1,000 USD/ha/yr)				
Mean	97	177	228	306
Standard deviation	23	40	31	68
5th percentile	59	110	177	194
95th percentile	138	244	278	420
Probability (Profit > 0) (%)	99	99	99	99
NPV (1,000 USD/ha)				
Mean	262	589	539	916
Standard deviation	131	227	180	374
5th percentile	57	223	244	310
95th percentile	486	997	839	1,512
Probability (NPV > 0) (%)	98	99	99	99

3. Adoption of Recirculating Aquaculture System in large pangasius farms

- Adoption rate is relatively low (23%). Lack of trust in receiving a price premium, inadequate access to finance and uncertainty about the actual performance of RAS seem to be constraints for the adoption of RAS.
- RAS with lower initial investment, expected higher yields and a guarantee of a price premium for ASC-certified pangasius is likely to encourage farmers to adopt RAS, especially in areas suffering from salt intrusion and among younger farmers with a higher level of education and a higher household income.

4. Price transmission along the Vietnamese pangasius export chain: A case of Poland market

- The transmission of price changes from Polish markets back to Vietnamese pangasius farmers is a positive signal for farmers to invest in sustainable production methods, as consumer price premiums likely flow back to the farm.

Conclusions and implications

- The introduction of technological innovations allowing for higher stocking densities and better quality of pond water RAS could potentially increase the pangasius yields.
- Farmers are generally positive about the economic performance of RAS. Crucial factors leading to the improved economic performance are improved yields and prices.

- The adoption of RAS is relatively low by large farms.
- In the Polish-Vietnamese pangasius supply chain, price signals at the retail stage transmit back to stages of wholesale, export and Vietnamese pangasius farms

Conclusions and implications

- Policy makers can stimulate the introduction of RAS by targeting male farmers younger than thirty-two years old with higher education levels, higher household income and with farms located in salt water intrusion regions.
- Credit programs might be established that link access to credit with farm investments targeting sustainability.
- Establishing pioneer farms demonstrating the use of RAS, accumulating of sufficient local technical capacity of RAS, and conducting technical training on RAS.
- Processors and retailers could provide and guarantee a price premium for certified pangasius.

Study completion (Sep 2012-Sep 2016)

Study	Publication
1. Technical ineffeciency of of Vietnamese pangasius farming: A data envelopment analysis	• Accepted for publishing in Aquaculture economics and management (2018)
2. Economic feasibility of Recirculating Aquaculture System in pangasius farming	• Published in Aquaculture economics and management (2016)
3. Adoption of Recirculating Aquaculture System in large pangasius farms: A choice experiment	• Published in Aquaculture (2016)
4. Price transmission along the Vietnamese pangasius export chain	• Published in Aquaculture (2017)

Thank you for your attendance!