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Antimicrobial Stewardship Behaviour among Livestock Farmers in Bangladesh: Integrating Veterinary Trust, Risk Perception, and Social Norms

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ABSTRACT

Misuse of antimicrobials in livestock production has been linked to treatment failure, residues of antimicrobials, loss of money, and the overall emergence of antimicrobial resistant. This paper will investigate the behavioural principles of antimicrobial stewardship in Bangladesh among livestock farmers using veterinary trust, risk perception, social norms, stewardship intention, and stewardship behaviour. There was a simulated survey data of 490 livestock farmers who was analysed using partial least squares structural equation modelling. The measurement model indicated good reliability of indicators, internal consistency, convergent validity and discriminant validity. The structural model accounted 49.8 percent of the variance in the intention to be an antimicrobial steward, and 58.5 percent of the variance in stewardship behaviour. Social norms, veterinary trust, and risk perception had a strong positive influence on the intention to stewardship. The direct impact on the stewardship behaviour was the most significant on the intention of stewardship. There were also significant direct impacts of veterinary trust, risk perception and social norms on behaviour. All the three relationships were partially mediated by stewardship intention. Risk perception generated the greatest overall impact on behaviour, then veterinary trust and social norms. The results imply that factors other than knowledge provision are necessary to promote responsible use of antimicrobials. It should be accompanied by effective interventions that help to build confidence in veterinary professionals, enhance the knowledge of farmers on antimicrobial resistance, and create supportive community expectations. The research offers a systematic model of behaviour to guide the future field-based research and design of stewardship programmes in livestock production.

INTRODUCTION

The use of antimicrobials is significant to livestock production. They promote the treatment of disease, minimize the suffering of animals, and safeguard the farm productivity. Their worth, though, is a matter of proper and cautious use. Redundant treatment, wrong dosage, not completing courses of treatment, routine preventive therapy and neglecting withdrawal phases can diminish the effectiveness of the treatment (Samad, 2024). These practices can also result in antimicrobial residues in animal products and development of antimicrobial resistance.

The farm level decisions are becoming more and more related to antimicrobial resistance. Livestock farmers make their own decisions on when to consult with professionals, the type of medicine, the duration of treatment, and whether to withdraw or not. These choices depend on the economic pressure, the availability of veterinary care, prior farming experience, medicine availability, social expectation and trust towards animal health professionals (Sayed *et al.*, 2022). The use of antimicrobials is not just a technical issue as well. It is a social and behavioural problem as well.

Bangladesh has varied livestock industry. It consists of domestic farms, small business enterprises, poultry businesses, dairy farms, and small livestock systems (M. Islam *et al.*, 2024). Farmers are likely to work with resource constraints. The veterinary services might be far, costly, or inaccessible. Sellers of medicine and practiced

farmers can thus become valuable sources of medical advice. Formal rules, in this case, might not be effective in promoting responsible use of antimicrobials.

The concept of antimicrobial stewardship is a set of co-ordinated activities aimed at safeguarding the efficacy of antimicrobial medicines (Hossain *et al.*, 2022). At farm level, stewardship involves providing professional consultation, correct diagnosis, appropriate choice of medicine, correct dosage, completion of treatment, safe disposal, maintenance of treatment records, maintenance of treatment records, withdrawal-period compliance and prevention of disease. These involve practices which involve ability and motivation (Choudhury, 2022). A farmer can know what he/she should do but he/she can still not uptake it due to the cost, habit, poor access to veterinary services or a social influence effect of other people.

The veterinary trust would probably be at the core of this process. Farmers who regard veterinarians as competent, honest as well as animal welfare conscious might also be more ready to accept professional advice (Jacobsen *et al.*, 2023). The uncertainty can be alleviated because of trust in making treatment decisions. It can also make instructions which are contrary to the traditional practice or which are the advice of informal medicine sellers more acceptable.

Another behavioural aspect that is important is that of risk perception. When farmers feel that improper use of

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antimicrobials will lead to treatment failure, monetary loss, resistant infection, unsafe food, or even injury to human health, there is a possibility that they will use antimicrobials in a more responsible manner (Trinchera *et al.*, 2025). Minimal risk perception can stimulate routine or precautionary use. It can also alleviate the worry of insufficient treatment and withdrawal symptoms.

Antimicrobial decisions may also be influenced by social norms. The decisions made by farmers are not made in isolation. They look at what other farmers do and react to demands of veterinarians, family members, buyers, business partners and community leaders (Chowdhury *et al.*, 2021). With responsible use of antimicrobials being viewed as a normal practice and socially acceptable, it becomes easier to uphold stewardship. Once the use of informal medicine is common, however, inappropriate practice might be accepted by society.

Behavioural intention is what provides a transition between these influences and actual behaviour. The intention to consult a professional and follow guidance on treatment may be reinforced by initially trust, perceived risk and social expectations to a farmer (Foyssal *et al.*, 2024). Such an intention can then be converted to stewardship behaviour. Intention is unlikely to provide an explanation to all behaviour, but it would be a significant immediate predictor.

The current body of research on livestock antimicrobials tends to focus on knowledge, prevalence, medicine use, or resistance awareness (Caekebeke *et al.*, 2021). There are limited studies that incorporate professional trust, risk perception, social influence, behavioural intention, and actual stewardship practice into a single structural model. This constrains the knowledge of the interaction of these factors.

This gap is filled in the current study. It builds and tests a PLS-SEM model that connects the variables of veterinary trust, risk perception and social norms with antimicrobial stewardship intention and behaviour. There are three objectives of the study (Nirjus, 2025). First, it evaluates how the direct impacts of veterinary trust, risk perception and social norms influence the intention of stewardship. Second, it looks at their immediate impacts on stewardship behaviour. Third, it assesses the intervening effects of stewardship intention (Hasan *et al.*, 2025).

The model has a realistic value. It assists in determining the emphasis of the stewardship programmes on the relationships between veterinarians, communication of risk, social influence, and commitment to behaviour (Sani *et al.*, 2023). It also offers a systematic setup that would be later on examined through field-collected information of livestock farmers in Bangladesh.

LITERATURE RIREVIEW

Antimicrobial stewardship in livestock production

The aim of antimicrobial stewardship is to maintain the efficacy of antimicrobial medicines, and to have sick animals treated accordingly (King *et al.*, 2025). Stewardship

of livestock farming has a balance between animal health, productivity, food safety and citizen health. It does not imply the complete avoidance of antimicrobial treatment. Rather it encourages reasonable, focused, professionally informed use (Elbehiry & Marzouk, 2025).

There are various practices associated with farm-level stewardship. Prior to treatment, farmers are advised to establish suitable diagnosis (Hassan *et al.*, 2021). They ought to take the appropriate antimicrobial, dosage, route, and duration. When clinical manifestations vanish, the treatment should not be discontinued unless indicated by professionals. Without instruction, farmers are not supposed to use remaining medicines (Raihan *et al.*, 2026). They ought to keep treatment records and observe withdrawal before the sale of milk, meat or eggs.

Stewardship also involves preventive management. Disease occurrence can be reduced by vaccination, farm hygiene, isolation of sick animals, use of safe feed and water, ventilation and biosecurity (Md. Z. Islam *et al.*, 2022). The pressure of the disease is decreased to reduce the necessity of antimicrobial treatment. Stewardship thus is a conglomeration of treatment and preventive farm management.

Responsible use may be hindered by behavioural obstacles. The farmers will be able to buy antimicrobials directly due to the absence of veterinary services (Kalam *et al.*, 2022). They can make use of drugs with previous experience. Urgent financial need can promote under-dose or premature discontinuation of treatment. The possibility of animals being lost can also lead to unnecessary treatment due to the fear (Rahman *et al.*, 2025). The conditions of decisions made must therefore be dealt with in effective stewardship programmes.

Veterinary trust

Trust demonstrates how confident one can be in the knowledge, honesty, reliability of another party, his intentions (Sumi *et al.*, 2025). Veterinary trust is an issue of livestock health decision making because farmers trust that the veterinarian can accurately diagnose, prescribe appropriate therapy, discuss medicine usage, and in the best interest of both the farm and the animals (Unicomb *et al.*, 2021).

Trust plays a crucial role particularly in the cases where farmers are not able to independently judge the technical advice (Murshid Hasan, 2025). Selection of antimicrobials needs information about the causes of diseases, properties of medicines, their dosage, antimicrobial resistance, and withdrawal time. Farmers tend to rely on professional judgement. This reliance can be tolerated when the trust between veterinarians is high (Arifuzzaman *et al.*, 2025). As farmers can be more open about treatment history, adhere to directions, and resist alternative guidance.

The trust can have an effect on the intention and behaviour. A farmer that has confidence in veterinarians might be intending to seek them out in subsequent treatment (S *et al.*, 2025). The dosage instructions, full treatment and withdrawal recommendations can also

be adhered to by the same farmer (Imam *et al.*, 2023). Trust may consequently work via a designed behavioural pathway and through direct obedience.

Mistrust can have a contrary effect. There is a risk that farmers think professional consultation is costly, unnecessary, or irrelevant to real-life farming conditions (Usman *et al.*, 2024). They might want the recommendation of medicine peddlers or neighbouring farmers. These decisions can lead to the possibility of the wrong choice of medicine and its use.

Following this line of reasoning, the intention and behaviour of stewardship will be reinforced through veterinary trust (Skjølstrup *et al.*, 2021).

H1: Veterinary trust positively influences the intention of antimicrobial stewardship.

H5: Veterinary trust has a positive effect on antimicrobial stewardship behaviour.

Antimicrobial resistance risk perception

Risk perception is the decision made by an individual on the probability and severity of the harm (Samad, 2024). Perceived risk in antimicrobial use can include failure of treatment, resistant infection, extended illness, negative financial infliction on a farm, unsafe food products or general harm to human health.

Farmers might vary in the interpretation of these risks. Others can consider antimicrobial resistance to be remote or something pertinent to hospitals. There is a chance that others can relate misuse with the failure to treat livestock (Sayed *et al.*, 2022). Risk perception is behaviourally significant when the threat is perceived to be serious and personally pertinent.

When a farmer feels that partial treatment might enhance resistance, he may be more motivated to finish the prescribed treatment (M. Islam *et al.*, 2024). When a farmer is aware of risks of residue, he or she may be ready to watch withdrawal periods. Financial implications can also be used to encourage more prudent utilization, especially when resistant disease poses a threat to the productivity of herd or flock (Hossain *et al.*, 2022).

Risk communication should go past the general warning messages. Farmers should be well informed on how specific practices will produce specific results (Chowdhury *et al.*, 2021). The messages ought to relate the inappropriate use to animal recovery, efficacy in medicine, access to the market, safety of the consumers and farm income.

Increased risk perception is thus likely to reinforce desirable intention and actual practice of stewardship.

H2: The perception of risk to antimicrobial resistance has a positive impact on the intention to practice antimicrobial stewardship.

H6: Antimicrobial resistance risk perception has a positive effect on antimicrobial stewardship behaviour.

Social norms

Social norms are defining terms of the perceived trends and expectations of a societal setting. Descriptive norms

deal with what is commonly done by other people. Injunctive norms have to do with what significant individuals approve or anticipate (Jacobsen *et al.*, 2023).

Both forms of norms may influence livestock farmers. A farmer can look at how neighbouring farmers use the services of veterinarians, undergo treatments, or withdraw. These observations bring an impression of common practice (Trinchera *et al.*, 2025). The farmer can also act on the expectation of veterinarians, family members, buyer, farm partners and consumers.

When responsible practices are visible and honored, social norms are able to facilitate stewardship. The discussion inside the community can result in farmers using the veterinary guidance as a routine aspect of livestock management (Choudhury, 2022). Antimicrobial residues could be given increased attention due to buyer expectations. Informal accountability may also be formed by farmer groups.

Inappropriate use can also be supported through social norms. With medicine readily available without prescription, direct purchase might even be socially acceptable. Frequent antimicrobial application can be emulated by successful farmers (Foyssal *et al.*, 2024). The informal advice can be more socially credible than the professional advice.

To conduct this study, the descriptive and injunctive items are integrated into a single construct of reflective social norms (Caekebeke *et al.*, 2021). This is indicative of larger social pressure on the antimicrobial choices.

H3: Social norms have a positive effect on antimicrobial stewardship intention.

H7: There is a positive impact of social norms on antimicrobial stewardship behaviour.

Stewardship intention and behaviour

Behavioural intention is a measure of preparedness and willingness to do something in the future. It embodies what people intend or anticipate doing (Nirjus, 2025). Plans that may involve a stewardship intention may be manifested through plans to always consult veterinarians, only use antimicrobials when there is need, adhere to dosage, treatment, observe withdrawal, record keeping, and reinforce disease prevention (Hasan *et al.*, 2025).

With intention, there is a likelihood that behaviour will be predicted since behaviour is highly probable to be undertaken upon the occurrence of possibilities (Sani *et al.*, 2023). Farmers that have a high intention of stewardship may find it less tempting to make unplanned choices in treatment. They can also prepare beforehand by finding contacts of veterinarians or keeping records of treatments (King *et al.*, 2025).

There can be a discontinuity between intention and behaviour. Planned action can be derailed by cost, lack of medicine, disease emergencies, time pressure and inaccessibility of veterinary care (Elbehiry & Marzouk, 2025). Intention is then considered to be a significant yet not complete predictor.

The immediate antecedent of behaviour in the current

model is the stewardship intention (Hassan *et al.*, 2021). It is also loaded with a portion of the impacts of veterinary trust, risk perception, and social norms.

H4: The intention of antimicrobial stewardship positively influences antimicrobial stewardship behaviour.

Integrated conceptual model

There are five constructs of the conceptual model. Exogenous predictors are veterinary trust, perception of risk and social norms (Raihan *et al.*, 2026). The intention of stewardship is an endogenous construct and a mediator. The last consequence is the stewardship behaviour.

The model suggests seven direct relationships. It also puts forward three indirect relations by stewardship intention (Md. Z. Islam *et al.*, 2022). It is this structure that enables the measurement of professional, cognitive, social, motivational and behavioural factors.

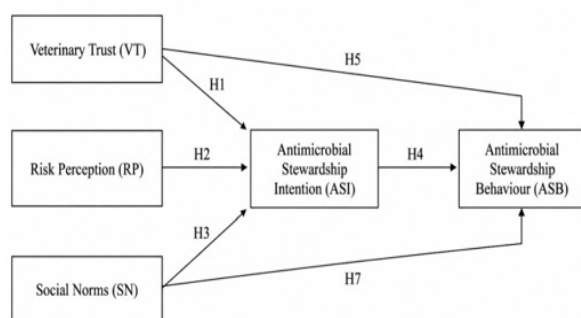


Figure 1: Conceptual framework

MATERIALS AND METHODS

Research design

The research involved a quantitative explanatory design. The proposed relationships have been measured using partial least squares structural equation modelling (Kalam *et al.*, 2022). It was chosen that PLS-SEM was used since the model included a number of latent constructs, a number of indicators, the direct effects, indirect effects and two endogenous outcomes.

It was analyzed with a simulated cross-sectional survey data. The data was designed to replicate plausible demographic distributions, variable variation, construct reliability and theoretically consistent structural models. It was constructed to develop models, demonstrate analytically and prepare surveys ahead (Rahman *et al.*, 2025). It is not a set of answers obtained among real livestock farmers.

Study context and simulated sample

The data set was a sample of 490 livestock farmers in the eight administrative divisions in Bangladesh. The sample profile comprised of dairy, beef, goat, sheep, broiler, layer, duck, and mixed livestock farms. The size of the farms was small household based and big business farms. Gender, age, education, farming experience, exposure to training, access to veterinary services, frequency of consultation, practice of record keeping and obtaining non-prescription antimicrobials were the diversity factors

among the simulated respondents (Sumi *et al.*, 2025). The inclusion of these characteristics was to capture the soil and environment diversity of livestock production in Bangladesh.

The complete values of the measurement items were included in all 490 cases. None of the cases were excluded in the final analysis. All Likert answers fell within the range of valid scale.

Survey instrument

The questionnaire had demographic and five key constructs. The constructs of interest included veterinary trust, risk perception, social norms, antimicrobial stewardship intention and antimicrobial stewardship behaviour.

The six indicators of veterinary trust were used to measure it. The questions evaluated trust in veterinary guidance, treatment options, dosage details, diagnostic skills, risk clarification, and readiness to adhere to the professional advice (Unicomb *et al.*, 2021).

There were seven indicators to measure risk perception. The items were on diminished antimicrobial effectiveness, failure of treatment, threat on human health, incomplete treatment, untreated, loss in finances, and residual antimicrobials.

There were nine indicators of social norms. There were four items that demonstrated descriptive norms. Five items portrayed the norms of the injunctive (Murshid Hasan, 2025). The nine items were lumped together in the last model to represent a single reflective social norms construct.

There were seven indicators of stewardship intention. The captured items are aimed at seeking professional advice, preventing unnecessary use, adherence to dosage and duration, treatment, adherence to withdrawal, record keeping and enhancing prevention practices.

Ten indicators were used to gauge stewardship behaviour. These indicators measured actual consultation, targeted treatment, dosage adherence, disease treatment adherence, withdrawal adherence, record keeping, prevention of left over use, prevention of sharing of medicines, safe disposal and disease prevention (Arifuzzaman *et al.*, 2025). Veterinary trust, perception of risk, social norm and stewardship intention were scaled on five points agreement scale. The measurement of stewardship behaviour was in a five-point frequency scale.

Data preparation

This data was read into RStudio as Microsoft Excel data. Column names were cross-referenced with the measurement specification. All indicator variables were put into numeric format.

Any other responses that fell beyond a valid range of one to five were not considered as valid. Missing values were assessed at item and case level (S *et al.*, 2025). Cases where the missing values of measurements were over 20 would have been omitted. The remaining small missing values would have been filled in with item medians. This did not

result in any missing data in the final dataset once it was prepared.

All items and constructs were calculated using descriptive statistics. Skewness and kurtosis were analyzed to determine extreme distributional issues. The values were within the appropriate ranges of analysis of a survey.

Model specification

There were five reflective constructs in the measurement model. There were six indicators of veterinary trust. There were seven indicators of risk perception (Imam *et al.*, 2023). There were nine indicators of the social norms. There were seven indicators of the intention of stewardship. There were ten indicators of stewardship behaviour.

The structural model identified the predictors of stewardship intention: veterinary trust, risk perception, and social norms. The same three constructs and intention to stewardship were identified as the predictors of stewardship behaviour.

Seven direct hypotheses were thus tested in the model (Usman *et al.*, 2024). There were also three indirect effects estimated using stewardship intention.

Analytical procedure

The analysis has been performed in RStudio with the SEMinR package. The reflective constructs were weighed with mode A. Path weighting was used for the inner model.

The analysis was done in two steps. The first assessment was conducted on the measurement model. Outer loadings were used to test the reliability of indicators. Cronbach alpha, rho A and composite reliability were used to test the internal consistency. To measure convergent validity, average variance extracted was used.

The discriminant validity was tested by using HTMT, bootstrapped confidence intervals of HTMT, Fornell-Larcker criterion and cross-loadings (Skjølstrup *et al.*, 2021). Collinearity was evaluated using full-collinearity VIF, and inner-model VIF.

Path coefficients, bootstrapped standard errors, t-values, p-values, and confidence intervals were used to evaluate the structural model. Bootstrap samples considered were 5,000. The endogenous constructs R² and adjusted R² were studied. Cohen's f² was used to evaluate effect size.

There were specific indirect effects on the veterinary trust, risk perception and social norms using the stewardship intention (Samad, 2024). The first comparison was between direct, indirect and total effects to identify the nature of the mediation.

Research integrity

The data used in this study was artificially created. There were no human participants involved. No personal information was collected. One should then view the results as a showcased example than as a direct expression of behaviour of farmers.

The questionnaire should be administered to actual

livestock farmers in future studies in order to have the relevant ethical approval and informed consent (Sayed *et al.*, 2022).

RESULTS AND DISCUSSION

Respondent and farm profile

The largest proportion of respondents in the simulated sample was comprised of male respondents. There were 349 male respondents, which constituted 71.22 % of the respondents. The number of female respondents was 132 or 26.94%. The other gender was found in 5 respondents representing 1.02% and four respondents representing 0.82% never gave information about their form. This distribution thus indicates that the decision of livestock farming was majorly carried out by the male farmers.

The group of farmers aged 35-44 years was the largest group of age. This sample consisted of 172 respondents and represented 35.10% of the entire sample. The second-largest was the group of farmers aged 45-54 years with 117 respondents or 23.88%. Another 108 respondents constituting 22.04 years were between the ages of 25-34 years. The farmers under 25 years of age and 55 years of age and above constituted 9.59 and 9.39, respectively. Generally, the majority of the respondents were middle-aged adults.

The respondents were mostly at the secondary level of education. There were 164 farmers who had done secondary education and this was 33.47 of the sample. Out of the 500 respondents, higher secondary education was reported by 98 (20.00) and 92 respondents (18.78) had completed their primary education. Diploma or vocational qualifications constituted 10.61, bachelors and postgraduate qualifications were 8.78 and 2.24 respectively. Thirty or 6.12% people had no formal education. The results show that the educational attainment of most farmers was either basic or intermediate.

The most prevalent farm-size category was small commercial farms. A total of 251 respondents operated small commercial farms, accounting for 51.22% of the sample. Medium commercial farms had 113 respondents or 23.06% respondents. Household or subsistence farms occupied 84 respondents or 17.14%. The smallest group were large commercial farms with 42 respondents or 8.57 %. The allocation thus indicates the high level of small-scale commercial production of livestock.

The majority of the respondents had not been under formal training in regards to animal health or the use of antimicrobials. Out of the sample, 320 participants were found to be untrained with no formal training, which represents 65.31% of the sample. It was found that only 170 respondents or 34.69% had undergone relevant training. This observation implies that there is a significant training gap and that a significant percentage of farmers might base their treatment choices on experience, informal recommendations or even medicine peddlers.

There was a wide variation in veterinary consultation practice. One hundred and nineteen respondents or 24.29 % of them had not approached a veterinarian

prior to administration of antimicrobials. In contrast, 111 respondents or 22.65% always sought veterinary advice. Ninety-eight (20.00) respondents said that they consulted sometimes and 83 (16.94) respondents said that they consulted often. Another 79 participants who constituted 16.12 % consulted infrequently. The findings demonstrate a disproportionality in the professional veterinary attendance. There was a mixture of practices of treatment records. One hundred and seventy-four respondents or 35.51% of the total respondents kept records occasionally but 167 respondents or 34.08% kept regular records. Nevertheless, 149 people (30.41) did not keep any treatment records.

Even though the majority of respondents documented treatments at least on some occasions, the share of those who did not have a record system was significant.

Purchasing of antimicrobials without prescription was common. There were 143 respondents who bought antimicrobials without prescription regularly (29.18 % of the respondents). Another 128 or 26.12% had done so occasionally. There was 104 (21.22) one-time purchasing among the respondents. Only 103 or 21.02 had not ever purchased antimicrobials non-prescriptionally. The results show that informal access to antimicrobials was prevalent in the simulated farmers.

Table 1: Simulated respondent and farm characteristics.

Variable	Category	Frequency	Percentage
Gender	Male	349	71.22
	Female	132	26.94
	Other	5	1.02
	Prefer not to disclose	4	0.82
Age group	Below 25 years	47	9.59
	25–34 years	108	22.04
	35–44 years	172	35.10
	45–54 years	117	23.88
	55 years or above	46	9.39
Education	No formal education	30	6.12
	Primary education	92	18.78
	Secondary education	164	33.47
	Higher secondary education	98	20.00
	Diploma or vocational education	52	10.61
	Bachelor's degree	43	8.78
	Postgraduate degree or above	11	2.24
Farm size	Household or subsistence	84	17.14
	Small commercial	251	51.22
	Medium commercial	113	23.06
	Large commercial	42	8.57
Formal training	No	320	65.31
	Yes	170	34.69
Veterinary consultation	Never	119	24.29
	Rarely	79	16.12
	Sometimes	98	20.00
	Often	83	16.94
	Always	111	22.65
Treatment records	Regularly	167	34.08
	Occasionally	174	35.51
	No records	149	30.41
Non-prescription purchase	Never	103	21.02
	Once	104	21.22
	A few times	128	26.12
	Frequently	143	29.18
	Prefer not to disclose	12	2.45

Construct descriptive statistics

The highest mean was on the stewardship intention. The same average was obtained in veterinary trust. The moderately positive risk perception and social norms and stewardship behaviour were close to the central scale

point.

Skew values were all small and negative. The values of kurtosis were also within a reasonable range (M. Islam *et al.*, 2024). There was no egregious non-normality in the construct distributions.

Table 2: Construct-level descriptive statistics

Construct	Mean	Standard Deviation	Skewness	Kurtosis
Veterinary Trust	3.380	0.961	−0.347	−0.528
Risk Perception	3.263	0.946	−0.080	−0.848
Social Norms	3.240	0.913	−0.159	−0.794
Stewardship Intention	3.390	0.985	−0.262	−0.752
Stewardship Behaviour	3.243	0.933	−0.228	−0.685

Construct correlations

As most correlated with stewardship behaviour. Intention

and behaviour were moderately related to veterinary trust, risk perception and social norms.

Table 3: Construct correlations

Construct	VT	RP	SN	ASI	ASB
Veterinary Trust	1.000				
Risk Perception	0.193	1.000			
Social Norms	0.217	0.273	1.000		
Stewardship Intention	0.483	0.472	0.515	1.000	
Stewardship Behaviour	0.470	0.495	0.462	0.722	1.000

Note: VT = Veterinary Trust; RP = Antimicrobial Resistance Risk Perception; SN = Social Norms; ASI = Antimicrobial Stewardship Intention; ASB = Antimicrobial Stewardship Behaviour

The correlations among the exogenous constructs were relatively low. This helped their conceptual difference and minimized the apprehension about redundancy of predictors.

Common method bias and collinearity

The initial factor (unchanged) had the highest variance at 36.81 % of total identifiable indicators.

Table 4: Common method bias diagnostics

Assessment	Result	Threshold	Decision
Harman first-factor variance	36.806%	Below 50%	No dominant single factor
Maximum full-collinearity VIF	2.541	Below 3.30	Acceptable

This was below the 50% reference value. The finding implied that there was no overall determinant in the measurement structure.

The values of full-collinearity VIF were 1.381-2.541. All the values were less than 3.30. The results did not

suggest any strong evidence of common method bias or undesirable full collinearity (Hossain *et al.*, 2022).

Indicator reliability

All external loadings were more than 0.70. A risk-

Table 5: Outer-loading summary

Construct	Number of Items	Minimum Loading	Maximum Loading
Veterinary Trust	6	0.751	0.857
Risk Perception	7	0.739	0.848
Social Norms	9	0.748	0.820
Stewardship Intention	7	0.796	0.871
Stewardship Behaviour	10	0.747	0.834

perception item had the lowest loading of 0.739. A stewardship-intention item had the highest loading of 0.871.

No zero loading confidence intervals. All the loadings were significant at $p < 0.001$. None of the indicators had

to be removed.

Reliability and convergent validity

Cronbach's alpha values ranged from 0.901 to 0.932. rho_A values ranged from 0.905 to 0.933. The correlation

in composite reliability was between 0.924 and 0.943. The values of reliability were all above 0.70. AVE values ranged from 0.601 to 0.690 and exceeded 0.50.

The constructs thus had a high internal consistency and convergent validity.

Table 6: Reliability and convergent validity.

Construct	Cronbach's Alpha	rho_A	Composite Reliability	AVE
Veterinary Trust	0.901	0.905	0.924	0.669
Risk Perception	0.906	0.911	0.926	0.641
Social Norms	0.917	0.918	0.931	0.601
Stewardship Intention	0.925	0.926	0.940	0.690
Stewardship Behaviour	0.932	0.933	0.943	0.622

Discriminant validity

The values of all the HTMT were below 0.85. Between the intention and the behaviour of stewardship, the most value was 0.777. Bootstrapped upper confidence limits were less than 1.00.

The findings validated that each construct was a unique concept (Chowdhury *et al.*, 2021). The same conclusion was reached by the Fornell-Larcker criterion and the cross-loading test. All the indicators were loaded more on the construct they were intended to measure than on the other constructs.

Table 7: HTMT ratios

Construct	VT	RP	SN	ASI	ASB
Veterinary Trust	—				
Risk Perception	0.214	—			
Social Norms	0.237	0.299	—		
Stewardship Intention	0.529	0.515	0.559	—	
Stewardship Behaviour	0.512	0.539	0.500	0.777	—

Note: VT = Veterinary Trust; RP = Antimicrobial Resistance Risk Perception; SN = Social Norms; ASI = Antimicrobial Stewardship Intention; ASB = Antimicrobial Stewardship Behaviour

Inner-model collinearity

The inner VIFs were all less than 3.00. The best predictor of behaviour was stewardship intention with the highest

value of 1.991.

Serious predictor collinearity did not therefore distort the structural coefficients.

Table 8: Inner-model VIF

Endogenous Construct	Predictor	VIF
Stewardship Intention	Veterinary Trust	1.073
	Risk Perception	1.105
	Social Norms	1.116
Stewardship Behaviour	Veterinary Trust	1.313
	Risk Perception	1.293
	Social Norms	1.369
	Stewardship Intention	1.991

Hypothesis testing

Veterinary trust had a positive effect on stewardship intention. H1 was thus justified. The intention was also positively influenced by risk perception, which confirmed H2. Among the three predictors of intention, the strongest influence was created by social norms. H3 was supported.

The direct impact of stewardship intention on stewardship

behaviour was the strongest. This supported H4. There were also significant positive direct impacts of veterinary trust, risk perception, and social norms on behaviour. H5, H6 and H7 were thus supported.

Risk perception had the greatest impact as one of the direct predictors of behaviour other than intention (Jacobsen *et al.*, 2023). The smallest direct effect, but significant relationship was with social norms.

Table 9: Structural relationships and hypothesis decisions

Hypothesis	Relationship	β	SE	t-value	p-value	95% Confidence Interval	Decision
H1	VT $\rightarrow$ ASI	0.347	0.034	10.098	<0.001	[0.282, 0.415]	Supported
H2	RP $\rightarrow$ ASI	0.307	0.033	9.346	<0.001	[0.243, 0.370]	Supported
H3	SN $\rightarrow$ ASI	0.356	0.032	11.285	<0.001	[0.294, 0.416]	Supported
H4	ASI $\rightarrow$ ASB	0.479	0.040	11.845	<0.001	[0.398, 0.554]	Supported
H5	VT $\rightarrow$ ASB	0.172	0.033	5.266	<0.001	[0.107, 0.236]	Supported
H6	RP $\rightarrow$ ASB	0.204	0.035	5.826	<0.001	[0.139, 0.276]	Supported
H7	SN $\rightarrow$ ASB	0.122	0.035	3.461	<0.001	[0.055, 0.194]	Supported

Note: VT = Veterinary Trust; RP = Antimicrobial Resistance Risk Perception; SN = Social Norms; ASI = Antimicrobial Stewardship Intention; ASB = Antimicrobial Stewardship Behaviour

Explanatory power

The combination of veterinary trust, risk perception, and social norms accounted 49.8% of the stewardship intention variance. This was a moderate level of explanatory power.

These four predictors accounted 58.5% variance of stewardship behaviour. The outcome was that the integrated model accounted a significant percentage of behavioural variance though other contextual issues were not contained in the model.

Table 10: Coefficient of determination

Endogenous Construct	R ²	Adjusted R ²	Interpretation
Stewardship Intention	0.498	0.495	Moderate
Stewardship Behaviour	0.585	0.582	Moderate

Effect sizes

The medium effects on the stewardship intention were on veterinary trust, risk perception, and social norms. Intention was impacted by social norms and then by veterinary trust.

There was a medium effect of stewardship intention on behaviour (Trinchera *et al.*, 2025). The direct effects of veterinary trust, risk perception, and social norms on behaviour were small. This trend indicates that to a large extent their influence was intentional.

Table 11: Cohen's f² effect sizes

Hypothesis	Relationship	f ²	Effect Size
H1	VT $\rightarrow$ ASI	0.223	Medium
H2	RP $\rightarrow$ ASI	0.170	Medium
H3	SN $\rightarrow$ ASI	0.226	Medium
H4	ASI $\rightarrow$ ASB	0.276	Medium
H5	VT $\rightarrow$ ASB	0.054	Small
H6	RP $\rightarrow$ ASB	0.077	Small
H7	SN $\rightarrow$ ASB	0.026	Small

Note: VT = Veterinary Trust; RP = Antimicrobial Resistance Risk Perception; SN = Social Norms; ASI = Antimicrobial Stewardship Intention; ASB = Antimicrobial Stewardship Behaviour

Mediation analysis

The three indirect effects were positive and significant. Veterinary trust also affected behaviour through an increased stewardship intention. The same way was taken to risk perception. Indirect impact was greatest with social norms.

The immediate impacts were also high. The symptoms

of the immediate and the indirect influences were good (Foysal *et al.*, 2024). The results thus showed some complementary partial mediation by all these three predictors.

The article discusses the direct and indirect and total effects in 4.13.

Table 12: Specific indirect effects

Mediation Path	Indirect Effect	SE	t-value	p-value	95% Confidence Interval	Mediation Type
VT → ASI → ASB	0.166	0.020	8.195	<0.001	[0.127, 0.207]	Complementary partial mediation
RP → ASI → ASB	0.147	0.021	7.134	<0.001	[0.108, 0.188]	Complementary partial mediation
SN → ASI → ASB	0.170	0.022	7.927	<0.001	[0.130, 0.213]	Complementary partial mediation

Note: VT = Veterinary Trust; RP = Antimicrobial Resistance Risk Perception; SN = Social Norms; ASI = Antimicrobial Stewardship Intention; ASB = Antimicrobial Stewardship Behaviour

Direct, indirect, and total effects

The total effect of risk perception on stewardship behaviour was the greatest. The second largest total effect was on veterinary trust. The smallest overall effect was produced by social norms, but the indirect component of this effect was higher than the direct component. The comparison indicates that various behavioural

mechanisms were worked in the predictors. There was a direct and an indirect effect of risk perception on behaviour, as well as an indirect effect on intention (Caekebeke *et al.*, 2021). There were almost equal direct and indirect impacts of veterinary trust. Social norms were mainly effective through enhancing intention of stewardship.

Table 13: Effects on antimicrobial stewardship behaviour

Predictor	Direct Effect	Indirect Effect through ASI	Total Effect
Veterinary Trust	0.172	0.166	0.338
Risk Perception	0.204	0.147	0.351
Social Norms	0.122	0.170	0.293

Discussion

The research formulated an amplified behavioural model of antimicrobial stewardship in the farmers of livestock. The findings revealed that the social norms, risk perception, and veterinary trust were strong predictors of stewardship intention (Nirjus, 2025). They also directly influenced the stewardship behaviour. The strongest immediate predictor of behaviour was intention which to some extent mediated the effects of all three antecedents.

The impact of veterinary trust on stewardship intention was moderate and had a smaller direct impact on behaviour. This insinuates that confidence in veterinarians will initially determine the way farmers will act (Hasan *et al.*, 2025). Farmers who think that veterinary advice is correct and helpful might be more ready to consult and take recommendations, adhering to the prescriptions, and to prevent the use of antimicrobials in an unjustified manner.

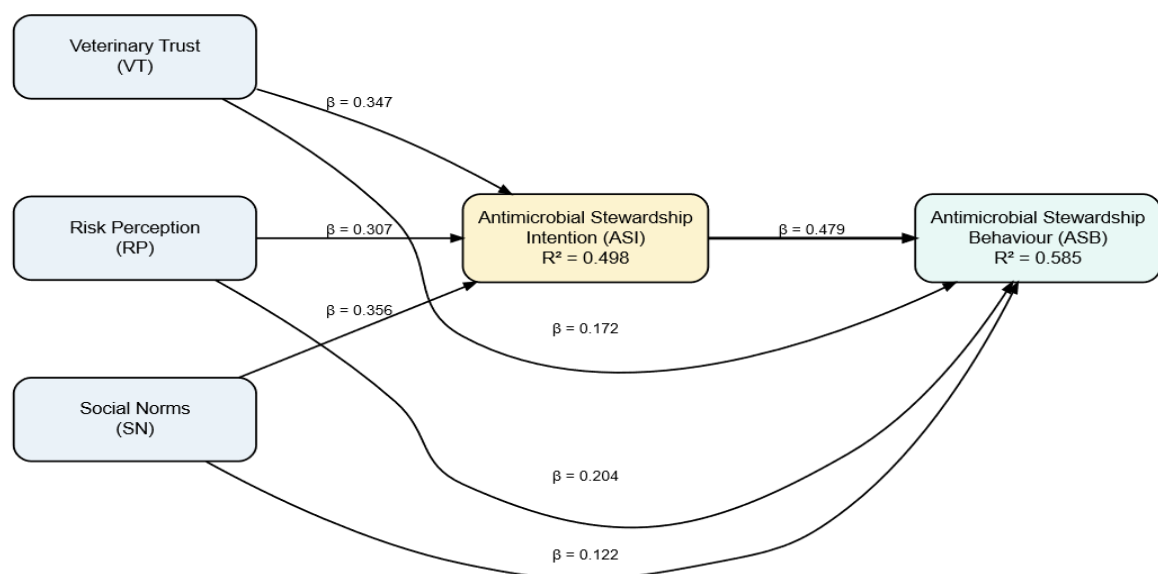


Figure 2: SEM Model Diagram of the Study

The immediate influence of trust on behaviour was also important. Trust can thus play a role in real time decision making even in the absence of complete designing of intentions. A trusted relationship with a veterinarian during disease outbreaks can promptly facilitate adherence to dosage, treatment regimen, and withdrawal counseling (Sani *et al.*, 2023).

These results emphasize the significance of quality of communication. Technical competence should not be used to assess the needs of veterinary services. Agriculturalists also react to articulation, openness, reverence, stability, and feasible interpretation (King *et al.*, 2025). A veterinarian that provides technically accurate advice, without clarifying why the advice is needed will not establish enduring trust.

Risk perception had a significant impact on intention and behaviour. It had the greatest overall impact on stewardship behaviour. It means that the knowledge of antimicrobial resistance in farmers can be the key to responsible practice.

The relationship between antimicrobial misuse and direct and visible outcomes should be linked by risk communication. Abstract warnings might not be very effective (Elbehiry & Marzouk, 2025). Risks that are associated with treatment failure, animal death, recurring medicine price, decreased production, unsafe supplies, and loss of purchaser trust are more likely to elicit a response by farmers.

The immediate impact of the perception of risk is that perceived damage might have an impact on immediate behaviour. When farmers believe that it is risky to misuse, they might not informally treat their victims despite a strong prior intention (Hassan *et al.*, 2021). The indirect effect indicates that future commitment is also influenced by the perceptions of risk.

The greatest influence was made on stewardship intention by social norms. This proves that the social environment affects antimicrobial decision making (Raihan *et al.*, 2026). One of the ways in which farmers develop intentions is through the consideration of what responsible farmers do and what important people expect.

The immediate impact of the social norms on behaviour was less. Its indirect impact was relatively high. It implies that social influence can be used primarily to influence commitment prior to behaviour. The expectations that are in the community might not necessarily lead to action. Their initial step is the establishment of a desire to be responsible (Md. Z. Islam *et al.*, 2022).

The given finding has practical significance. Farmers should not be viewed as lone decision-makers in stewardship programmes. Social expectations can be exerted upon by farmer groups, cooperatives, buyers, feed suppliers, medicine sellers, family members, and other local animal health workers (Kalam *et al.*, 2022). Apparent communal approval can normalize responsible use of antimicrobials.

The direct influence on behaviour was the highest with Stewardship intention. Farmers that had higher

intentions had higher chances of reporting responsible treatment practices (Rahman *et al.*, 2025). The f^2 of the medium indicated that intention was a significant factor in explaining behaviour.

The outcome also indicates that the information might not be sufficient. The farmers should develop particular undertakings with the aid of training. General awareness ought to be turned to actual plans (Sumi *et al.*, 2025). Farmers can be advised on who they will contact and how they will record treatment and how withdrawal periods will be observed.

The model accounted near half of the variation in stewardship intention, and over half of the variation in behaviour. This constitutes valuable explanatory power (Unicomb *et al.*, 2021). The results indicate that professional trust, perceived risk, social influence, and intention are all good behavioural foundations.

A large part of the variation was, however, not accounted for. Others might be veterinary access, cost of treatment, farm income, severity of disease, availability of medicine, regulation, pressure by buyers, prior successful treatment, and perceived behavioural control (Murshid Hasan, 2025).

The demographic profile also offers contextual information. There was a minimum of formal training. The sale of antimicrobials without prescription was not uncommon (Arifuzzaman *et al.*, 2025). Patterns of veterinary consultation were not consistent. These circumstances can undermine the stewardship despite positive attitudes.

The construct scores of responsible use of antimicrobials are moderate because the average construct scores are positive. They are not an indication of universal adoption. Means of behaviour were near to the mid-range of scale (S *et al.*, 2025). This means that there is still need of stewardship interventions.

The multi-level approach is supported by the mixed results. Farmers need to trust in professional relationship. They should have a clear knowledge of the risks of antimicrobials. They also require responsible use-sanctioned social environments (Imam *et al.*, 2023). The effects of these influences ought to be translated into particular intentions and routines.

Theoretical Implications

The research builds on the accumulated body of literature regarding antimicrobial stewardship by incorporating professional, cognitive, social, motivational and behavioural factors in a single model. Veterinary trust represents the professional relationship. Risk perception is cognitive evaluation. Social influence is expressed through social norms (Usman *et al.*, 2024). The motive to stewardship is a sign of motivation. Stewardship behaviour is a present practice.

The model demonstrates that trust, risk and norm do not work as exclusively direct predictors of behaviour. They also affect behaviour via intention. This gives a further elaboration on antimicrobial decision-making.

Of particular importance is the mediation outcomes. Complementary partial mediation was found between all three antecedents (Skjölstrup *et al.*, 2021). They were thus direct and intentional influence. The models of behaviour in the future must not be limited to study of direct effects only.

The findings also reinforce the concept that social norms can be viewed as an umbrella construct that includes observed communal practice and perceived social acceptance. This methodology encompasses the broader social context within which antimicrobial decisions are made.

Practical Implications

Trust-building should be a priority to the veterinary authorities. Farmers must have easy access to qualified animal health practitioners and communicate with them on a regular basis and in a dignified manner (Samad, 2024). Advice must be realistic and should be based on conditions in the farms. Explanations should be given by veterinarians why a medicine is required, how it is administered and what is likely to occur in case instructions are not followed.

The risk communication must be specific. The misuse should demonstrate to the farmers that it can cause treatment failure and financial loss. Antimicrobial residues and withdrawal time should be explained using simple language in messages (Sayed *et al.*, 2022). The visual instruction can prove to be helpful to those farmers who do not have a lot of formal education.

Stewardship programmes should be provided with social influence. Responsible use is an expectation within a community that can be established by farmer leaders, cooperatives, buyers, feed dealers and medicine sellers. Positive descriptive norms could be reinforced by publicity of responsible farms.

Intervention strategies need to incorporate medicine sellers. They serve as valuable sources of treatment-advice in most livestock facilities (M. Islam *et al.*, 2024). The use of training and accountability systems can minimize inappropriate recommendations.

Training programmes ought to shift away on awareness to action planning. The farmers need to be motivated to establish transparent processes of veterinary consultation, dosage and treatment completion, withdrawal, medicine storage and disposal (Hossain *et al.*, 2022).

Treatment records (digital or paper) are to be simplified. Farm record cards that were considered standard might assist farmers in the recording of the animal, medicine, dose, period of treatment, and withdrawal date.

Access to vets needs to be enhanced too. When there are no services available, trust and intention might fail to generate a behaviour (Chowdhury *et al.*, 2021). Access barriers can be minimized by the use of mobile veterinary clinics, telephone consultation, community animal health workers, and digital advisory systems.

Limitations and Future Research

The main limitation is the use of simulated data. The

results show the behavior of the proposed model at theoretically consistent conditions of surveys. They do not determine the real behaviour of livestock farmers in Bangladesh.

Causal interpretation is also restricted by the cross-sectional structure. Further studies need to gather field data in variety of regions and livestock systems (Hasan *et al.*, 2025). Representativeness would be enhanced by the use of probability-based sampling or well-stratified sampling.

Social desirability could affect self-reported antimicrobial behaviour. Survey responses should be supplemented in future studies by farm records, medicine purchase data and prescription data or direct observation.

The model can be further extended to cover veterinary access, perceived behavioural control, economic pressure, regulatory awareness, antimicrobial knowledge, and farm biosecurity (Raihan *et al.*, 2026). It might be possible to compare poultry, dairy, cattle, goat, small-scale, and commercial farmers via a multi-group analysis.

Longitudinal research would be able to analyze how trust, risk perception and intention would predict subsequent behaviour (Md. Z. Islam *et al.*, 2022). Intervention research might as well be done to determine whether there is an improvement in stewardship by veterinary communication and community norm strategies.

CONCLUSION

This paper constructed a behavioural model of the antimicrobial stewardship of livestock farmers based on veterinary trust, risk perception, social norms, stewardship intention, and stewardship behaviour. There were high reliability and validity of the measurement model. The structural model described significant proportions of intention and behaviour.

Social norms, risk perception and veterinary trust were found to be very strong agents of stewardship intention. The greatest direct influence on behaviour was through intention. The three antecedents also had a direct impact on behaviour. Their indirect intentional effects were massively felt.

The overall behaviour effect was the greatest of those generated by risk perception. Veterinary trust was next in line. Influence of social norms on behaviour was through intention. The findings indicate that the important aspect of antimicrobial stewardship involves beyond technical education.

Programmes are to reinforce veterinary relationships, convey practical antimicrobial risks, develop supportive community expectations, and assist farmers to translate awareness into tangible plans. Veterinary care access and easy systems of treatment records are required as well.

The model offers systematic basis of future field-oriented study in Bangladesh. It must be tested at the risk of empirical value relying on the data obtained on the real livestock farmers with the help of appropriate ethical practices.

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